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BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 87, No. 6, pp. 375–385 NOVEMBER, 1960

SOME EFFECTS OF ANIMALS ON THE VEGETATION OF THE NEW JERSEY PINE BARRENS

JACK MCCORMICK AND JOHN W. ANDRESEN

Numerous examples of the direct influences exerted by animals on the vegetation of the Pine Barrens were noted during the course of studies in the West Plains (Andresen, 1959) and on Middle Branch and McDonalds Branch watersheds in Lebanon State Forest (McCormick, in press), Burlington and Ocean Counties, New Jersey. This paper contains data on each type of animal influence that was observed, but no attempt is made to list influences which have been cited by other authors. Neither is there any suggestion that the effects chronicled here are of equal importance. Some have a very minor impact on the regional vegetation; others have widespread and enduring impacts and may contribute significantly to the faunal control of vegetation.

A. Effects of Insects The insect fauna of the Pine Barrens is varied and abundant (Smith, 1910; Weiss and West, 1924). Beyond doubt, the bulk of the population is herbivorous and exerts an important influence on the plant populations of the area. Although many instances of insect-feeding were observed on individual plants, only cases in which the attacks were frequent enough to be of significance to the vegetation are described. Examples of insect defoliation were, of course, the most obvious type of damage. However, a careful, but fruitless search was made for evidence of mortality caused by bark beetles and other types of insect damage which have been found to be of importance in other areas.

Several instances of insect damage which were observed are not detailed below. A positive relation was noted between wind-breakage of limbs and trunks and the occurrence of extensive carpenter-ant galleries in oak trees. However, the relative importance of the ant excavations and of decay produced by fungi in the same parts of the trees was not ascertained. The effects of pine sawflies on the vegetation and food relations of the forest is very significant, but these effects are discussed in detail in a paper by McCormick and Andresen (In press). Insects which invade trees killed by fire are of importance in hastening the fall of snags and the decomposition of logs and branches, but they apparently do little or no harm to living trees.

1. Defoliation By Locusts. Brunner (1887) was the first to describe damage to forests by the post oak locust (*Dendrotettix quercus*). In the spring of 1886 he found "vast numbers among the post-oak timber lying between the towns of Washington and Brenham, in Washington County

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[Texas]. These were so numerous in one locality that they completely defoliated the trees of the forest, even to the topmost twigs." By the spring of 1887, the locusts had completely defoliated the trees in an area of at least 50 square miles (Brunner, 1891).

The post oak locust was first recorded in New Jersey by Smith (1910) on the basis of a specimen collected at Bamber Lake, Ocean County, in 1907. The earliest account of the damage inflicted on Pine-Barren vegetation by the locust was given by Davis (1912), who reported infestations at Lakewood, Lakehurst, and Ridgway. He related that damage near Ridgway was so great that defoliated trees were noticeable from the windows of a moving train. The locusts were most common on the white oaks, although the foliage of scarlet oaks and other members of the red oak group had been utilized. In addition to being defoliated by locusts, some scarlet oaks near Ridgway were noted to bear many large woody galls of *Callirhytia punctata* on their limbs and to have lost the ends of many branches due to damage by the egg-laying activities of the seventeen-year cicada. Davis (1912) found that the locusts had partially defoliated plants of *Rhus copallina*, but did not attack adjacent individuals of *Prunus serotina*. Although the infestation at Ridgeway was heavy when it was discovered on August 16, 1910, not a single individual was found in the area during August, 1912 (Davis, 1915).

Weiss (1927) quoted the following report on *Dendrotettix* by the watchman in the 70-foot-high Cedar Bridge fire tower. On August 3, 1926, "There were many of them when they struck tower, came like a cloud and could hear them roar through the woods. It was impossible to come down out of the tower without stepping on them and they were all gone in a day or so." This report is unusual, for the majority of the locusts in New Jersey are brachypterous and, hence, unable to fly. Dr. Silas Little, Jr. (personal communication, 1960) considers the report a hoax.

Fox (1928) noted that the locust is usually very rare and local in a limited portion of the Pine Barrens, but at intervals it increases sufficiently in numbers to become quite injurious to oaks. He reported an outbreak about five miles southeast of New Lisbon which was at its peak on August 10, 1922. In early August, 1926, another outbreak was reported about two miles southeast of Red Lion, Burlington County. This outbreak was evidently of a very brief duration, for when Fox visited the locality on August 26 he failed to find a single individual (Fox, 1928). The factors involved in these rapid changes in population have yet to be explained.

The post oak locust has partially or completely defoliated at least 25 per cent of the arborescent oaks on Middle Branch watershed one or more times during the past quarter century. Damage was first noticed in 1935 on the controlled-burning plots near Mount Misery, New Jersey, at the south-

western extremity of the watershed (Little and Moore, 1945). Rehn and Rehn (1938) reported that on June 2, 1936, locusts were found to be completely defoliating oaks in an area approximately two miles long and one and one-half miles wide, between the North and South branches of Mount Misery Brook. The most heavily ravaged area, centered on Middle Branch watershed, contained about 500 acres. The infestation reached its peak about August 1, 1936, at which time the leaves of the arboreal oaks were reported to have been almost completely eaten so that the normal canopy was virtually non-existent (Rehn and Rehn, 1938). White oaks and chestnut oaks were almost completely defoliated, but shrubby species were only slightly injured. No apparent damage was done to the pines.

When the same authors returned to the area in 1937 few locusts were evident, but they observed that "the oaks, which were so badly defoliated by the 1936 infestation, were leafless, having been killed in the area of maximum concentrations of the locusts at that time" (Rehn and Rehn, 1938). In 1944, a new outbreak occurred in the same area (Rehn, 1946). "The occurrences were spotty, apparently governed by a preference for chestnut oak and similar species, but avoiding scrub oaks. The injury done was very great in a number of places, trees and saplings being almost completely defoliated, and the ground conspicuously covered with droppings." Defoliation, or possibly secondary infection, resulted in the death of many chestnut oaks along the northern divide of Middle Branch watershed. Most of the dead or dying stems have subsequently been removed, but in the area east of Glass Works Road some were still standing in 1959. The selective elimination of chestnut oak has effected a conversion of the canopy in small portions of the chestnut oak community on the watershed to a black oak-pine type. In some other portions the importance of chestnut oak in the canopy has been reduced, although the species is still predominant. Because pre-infestation measurements are not available, no quantitative descriptions of these canopy changes are possible.

The succeeding generations of locusts have apparently migrated eastward in the watershed (J. P. Allen, personal communication, 1954). This movement has been exceptionally slow, perhaps due to the fact that the population is brachypterous and unable to fly. The locusts were noted by Drs. M. F. Buell and J. E. Cantlon (personal comunication, 1954) near Butler Place Road in 1948 and 1949. In 1954, the present authors observed the locusts only on the easternmost section of the experimental watershed about 0.8 mile from Butler Place Road. In this area, several large chestnut oaks were 35 to 50 per cent defoliated, while scarlet oaks (*Quercus coccinea*) and black oaks (*Q. velutina*) were less than 10 per cent defoliated. None of the defoliated trees died during two years of observation.

In his 1912 paper, Davis described a phenomenon noted by the senior

author while working in an infested stand on the experimental watershed in Lebanon State Forest: "The excrement of the [locusts] . . . on the limbs fell with a rain-like pater on the dry leaves beneath." The insects are active in all stages of growth and feed both by day and night (Brunner, 1887). Thus, they are an important local group in the forest energy cycle. They harvest a tremendous amount of plant material, some of which is temporarily incorporated into their own bodies, but the bulk of which is added to the forest floor in an almost continuous rain of excrement.

2. Defoliation By Lepidopterous Larvae. Severe defoliation of oaks by a species of *Datana* was observed during the summer of 1956 on the Wharton Tract State Forest and Park, Burlington County, New Jersey, near the Carranza Monument. The infested area extended for approximately a quarter of a mile along a sandy road, but its width was not determined. All the leaves of many black and scarlet oaks had been reduced to fringed veins, but adjacent post, blackjack, and bear oaks (*Q. stellata, Q. marilandica, Q. ilicifolia*) were only slightly damaged. The area was not revisited.

The larvae of the Nantucket pine moth, *Rhyacionia frustrana* (Comst.), bore into and feed upon the buds of pines and thus destroy potentional terminal and lateral branches and their foliage. The depredations of the larvae have been considered to be an important contributory factor in the maintenance of the stunted growth form of pitch pines in the East and West Plains of the Pine Barrens (Stevens, 1940; Little, 1946). Gifford (1900, p. 239) probably referred to the pine moth in his statement that young stump sprouts of pitch pine were frequently killed by insects.

Moore (1936) reported heavy infestations of native pine moths throughout the Pine Barrens during the summer of 1931. On a 0.5 acre experimental plot in Bass River State Forest, Burlington County, he found that approximately 90 per cent of the 290 planted shortleaf pines and 1(natural seedling-sprout pitch pines had been injured by pine moth larvae. Both leaders and lateral branches were attacked. Wood (1936) made observations on pitch, shortleaf, jack (*Pinus banksiana*), loblolly (*P. taeda*), eastern white (*P. strobus*), scrub (*P. virginiana*), and red pines (*P. resinosa*) interplanted in a seven-year-old sprout oak stand on the Camp Ockanickon Experimental Forest on the west side of the Pine Barrens. His studies indicated serious damage to the hard pines as a result of the depredations of pine moth larvae. The population of the insect "was increasing in the interplantings until seemingly checked, for a time at least, by the extremely low temperatures of 1934."

Stevens (1940) made a survey of pine moth injury to pitch pines on two 0.01 acre plots in the East and West Plains during early July, 1939, when the infestation was heavy. At the time of his survey, Stevens estimated that from 31 to 81 per cent of all branch tips on 57 sampled trees had

been injured. The damage was less severe on the East Plains (average of 54 per cent of all tips infested) than on the West Plains (average of 66 per cent of all tips infested). He predicted that the activities of subsequent generations of the insect might result in a 100 per cent mortality of the current tips, but did not make later observations. He emphasized that "damage by the insects is a factor in keeping the pine suppressed at a point where it is most vulnerable to fire." Stevens further noted that the pines in stands which had not been burned for about fifteen years averaged about ten feet in height. "Little, if any, evidence of shoot moth damage is visible, indicating that if fire is kept out the pine out-grows its susceptibility to shoot moth attack."

During a period from 1955 through 1958, Andresen (1959) observed no pine moth injuries on 400 planted pitch pine seedlings in the West Plains and near Mt. Misery. However, occasional pine sprouts on natural coppice growth in the East and West Plains were observed to have been damaged by pine moth larvae. Minor damage to pitch pines by the larvae was noticed in various areas within the Pine Barrens during 1956 by Waters and Waterman (1957). However, there are no reports of recent instances of heavy infestations by the Nantucket pine moth in the region. To the present authors, it appears that Stevens overestimated the importance of the pine moth. Although it occasionally may occur in numbers great enough to affect significantly the growth of the majority of the pines in the Plains these outbreaks are of infrequent occurrence. The damage is quickly outgrown, although stem crooks may be noticeable for many years.

3. Reduction of Reproductive Potential By Acorn Weevils. The reproductive potential of black oak (*Quercus velutina*) is significantly reduced by the damage inflicted by acorn weevils (*Balaninus spp.*). The acorns of other oaks are also weeviled, but not in the same proportion to the total crop. None of more than 500 black oak acorns examined on Lebanon State Forest by the senior author during the autumn of 1954 were sound. Wood (1938), who worked in Lebanon State Forest, also observed that of the acorns of the various oaks, those of the black oak were most subject to damage by weevils.

In collections made during September 1953, 1954, and 1955, Little, Moorhead, and Somes (1958) found that 51 per cent of the bear-oak acorns (*Quercus ilicifolia*) in a Pine-Barren area with a light acorn crop and 11 per cent in an area with a heavy crop were weeviled. In October, 93 per cent of the acorns in an area with a light crop were weeviled. In another area, mice and other wildlife were estimated to have consumed 66 per cent of the bear-oak acorns and 32 per cent were destroyed by weevils, so that only 2 per cent of the crop was available for wildlife food or germinable.

Downs and McQuilken (1944), in studies in North Carolina and Georgia,

found that only 20 (*Q. velutina*) to 63 (*Q. alba*) per cent of the well-developed acorns are sound when they drop from the trees. Over a seven-year period, insects destroyed 30 per cent and birds and squirrels devoured 24 per cent of the acorn crop while it was still on the trees. Further test of acorns in fenced plots on the ground indicated that 82 per cent of the sound acorns and 94 per cent of those that were known to be insect infested were totally destroyed or so badly damaged that germination was impossible. Only 1 per cent of the sound acorns escaped damage, but a total of 18 per cent of all the fallen acorns germinated. Observations on unprotected sites indicated a rapid accumulation of superficially sound acorns on the ground in early autumn, with a peak from late September to early November, then a gradual decline due to insect damage and bird, rodent and deer feeding. On one study area where the deer population was very high, Downs and McQuilken found that during 4 of 5 years every acorn had been destroyed by late November to early February. During the other year, 10 per cent of the acorns survived.

These figures probably are indicative of the fate of acorns in the Pine Region, where the present authors have observed two bumper crops of chestnut oak acorns. More than 90 per cent of the acorns were estimated to have been undamaged when they reached the ground, but observations and periodical rephotographing of check plots indicated that nearly all subsequently were destroyed by rodents *in situ* or eaten by deer. During the winter of 1953–1954, the stomachs of three deer that were examined in Middle Branch watershed were all found to contain acorns in various stages of digestion. These were predominantly chestnut-oak acorns, but a few black and bear-oak acorns were mixed with them. Acorns that escaped damage by animals germinated in late autumn and put forth long radicles. However, the first frosts killed every chestnut oak seedling on the areas in which observations were made. A number of chestnut-oak acorns which were collected in the fall and grown indoors during the winter developed normally (E. C. Rhodehamel, personal communication). Thus, no inherent defect in the acorns caused mortality.

4. Spider Balds. The turret spider (*Geolycosa pikei*), a common species in the upland communities on Lebanon State Forest, excavates nearly vertical burrows to a depth of approximately 10 inches. The activities of the spider occasionally create a circular bald, from 1 to 3 inches in diameter, centered on the slightly elevated turret or burrow entrance.

At numerous places scattered mosses (*Polytrichum juniperinum*) were found around occupied burrows. At one station a dense patch of the moss was growing in an area about 4 inches in diameter. A few exploratory probes disclosed the existence of an abandoned spider burrow in the center of the patch.

5. Ant Balds. The upland portions of Lebanon State Forest are dotted with hundreds of roughly-circular "balds" that are 6 to 10 feet in diameter. These balds are virtually free of shrub growth and herbaceous undergrowth and have a cover composed of litter, mosses (*Polytrichum juniperinum*), and lichens (*Cladonia sylvatica*). Most of these balds are the sites of abandoned charcoal pits. However, a few balds were found which contained no excessive concentrations of carbon, had no unusual surface configuration, exhibited normal soil profiles, and therefore could not be charcoal pits. Excavations disclosed that most of these balds were inhabited by colonies of ants (*Acanthomyops subglaber* and *Tapinoma sessile*). In a few of the areas, no living ants were found, but a strong odor of formic acid was detected. The rhizomes of shrubs that grew in the ant balds were riddled with chambers that were occupied both by ants and termites (*Reticulitermes flavipes*) and the aerial portions of the shrubs showed evidences of frequent die-back. These balds were especially noticeable near the concrete monuments established at grid point 16 W on Middle Branch watershed and at 16 F on McDonalds Branch watershed. The locations are indicated on the maps in a paper by McCormick (In press).

B. Effects of Mammals Although more than 30 species of mammals have been reported from the New Jersey Pine Barrens (Stone, 1908; Connor, 1953), only a few of them have any marked effect on the vegetation. The most outstanding mammal influent is the Virginia deer (*Odocoileus virginianus*), a species considered to be so near to extinction in 1904 that the area was restocked with imported animals (Stone, 1908). As recently as 1922, it was reported that "comparatively few deer remain" in the Pine Barrens (Weiss and West, 1924). The most conspicuous and important action of deer on the vegetation results from their browsing. Because the whole aspect of deer browsing in the Pine Region has been thoroughly discussed by Little, Moorhead, and Somes (1958), and the observations of the present authors merely confirm their findings, deer browsing is not considered in this paper.

1. Deer Beds. Most deer beds are located in dense pine lowland communities. These are roughly circular areas, usually less than 10 feet in diameter, that are kept free of shrubs and herbs by repeated bedding and centrifugal browsing. The beds are covered with forest litter, but usually support a growth of mosses (*Polytrichum juniperinum*) and lichens (*Cladonia uncialis*). Abandoned deer beds of unknown ages were observed to be invaded centripetally by shrub roots from which suckers developed. In some cases, unused beds were covered by relatively dense stands of wintergreen (*Gaultheria procumbens*).

2. Antler Rubbing. Virginia deer also exert a minor influence on the vegetation through buck damage. Large, open wounds on a number of

oak trees and larger highbush blueberry stems (*Vaccinium corymbosum*) were produced by buck deer in their attempts to free their new antlers of velvet (Fisher, 1895). Frequently such wounds were found to completely girdle the stem and subsequently resulted in the destruction or deformation of the aerial portions of the tree or shrub. The wounds are also reported to present access routes for the entry of various injurious organisms (Lutz and Chapman, 1944), but the damage noted in the present study was chiefly of a mechanical nature. Wright (1949) noted antler-rub damage to several cultivated species in New Jersey. In New England, a survey revealed that one small plantation had been completely ruined and 50 per cent of the trees in another plantation had been injured by antler rubbing (Anon., 1931).

3. The Effect of Deer Urine on Mosses. Small, irregularly-shaped, yellowed patches of dead mosses, surrounded by healthy, green mosses were found at numerous stations throughout the upland communities of the experimental watersheds on Lebanon State Forest. Several of these areas were marked with wooden stakes and observed for several months. No change occurred in the proportion of dead to living individuals.

By coincidence, a deer was observed in the act of urination in a chestnut oak community. A notation was made of the location of this moss-covered site and it was revisited at weekly intervals. The plants withered during the first week and had not recovered, nor had the patch of dead moss enlarged, at the end of eight weeks when observations were discontinued.

Controlled experiments, utilizing human urine, were made at several stations on four species of mosses (*Polytrichum juniperinum, Dicranum scoparium, Ceratodon purpureus, Dicranella heteromalla*) during the summer of 1953. According to Prosser (1950), the nitrogenous constituents of mammalian urine are rather constant from species to species, so it would appear that the source of the urine is less important than the volume. In every case the treated mosses withered within one week of the initial application of urine, but mosses in adjacent, untreated plots, suffered no mortality. The limits of the blighted areas were stable throughout several weeks of observation. From these experiments and observations of the natural occurrence of urine blight, it is apparent that only mosses saturated with urine are killed.

When the human-urine test plots were revisited two years after the treatment, the dead mosses were still present, only slightly deteriorated, and had not been replaced to a noticeable degree by new growth. Seven years after treatment, in May, 1960, the dead mosses were still in place and showed little evidence of decay. A small colony of *Cladonia cristatella* had

become established in about five per cent of the area occupied by the dead moss patch. Several seedlings of a grass (*Panicum* sp.) and ragweed (*Ambrosia artemisiifolia*) also had begun to grow among the dead mosses.

4. The Effects of Small Mammal Excavations. Moles (*Scalopus aquaticus aquaticus*) and pine mice (*Pitymys pinetorum scalopsoides*) occur in upland areas throughout the Pine Barrens, except in the East and West Plains (Connor, 1953). Their tunneling habits result in widespread disturbances to the soil. Both animals are reported to excavate raised tunnels of similar size (Stone and Cram, 1918), but the mole is apparently more abundant than the pine mouse. The tunnels most frequently seen are within an inch or two of the soil surface. The roof is pushed upward and the soil surface and litter are ruptured. The ridges of exposed soil thus formed frequently are colonized by haircap moss (*Polytrichum juniperinum*) and pine seedlings. In areas which have not been burned for several decades, these ridges may represent the only litter-free areas available and mosses and pine seedlings may be almost entirely restricted to them. Narrow strips of haircap moss often mark the course of old tunnels.

Owing to the virtual absence of earthworms from the Pine Barrens. the tunneling of mammals, combined with the activities of ants, is of special significance because of the mixing and aerating effects. The extent of mammal tunneling is demonstrated strikingly after a forest fire. The mosses and thin litter are burned away from the low ridges, but on the undisturbed soil the compacted litter is only charred. Thus, the ridges stand out as anastamosing lines of white sand embossed on a background of blackened litter.

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ADDITIONS TO THE TERTIARY RUBY PAPER SHALE FLORA OF SOUTHWESTERN MONTANA

HERMAN F. BECKER

Investigations of the Tertiary Ruby flora from southwestern Montana are at present being conducted in the Palaeobotany Division of The New York Botanical Garden under a grant from the National Science Foundation. For providing facilities and assistance, my sincerest appreciation is here expressed to these Institutions, and specifically to Dr. Bassett Maguire, curator of the Herbarium, for helpful suggestions in regard to the family Limnanthaceae.

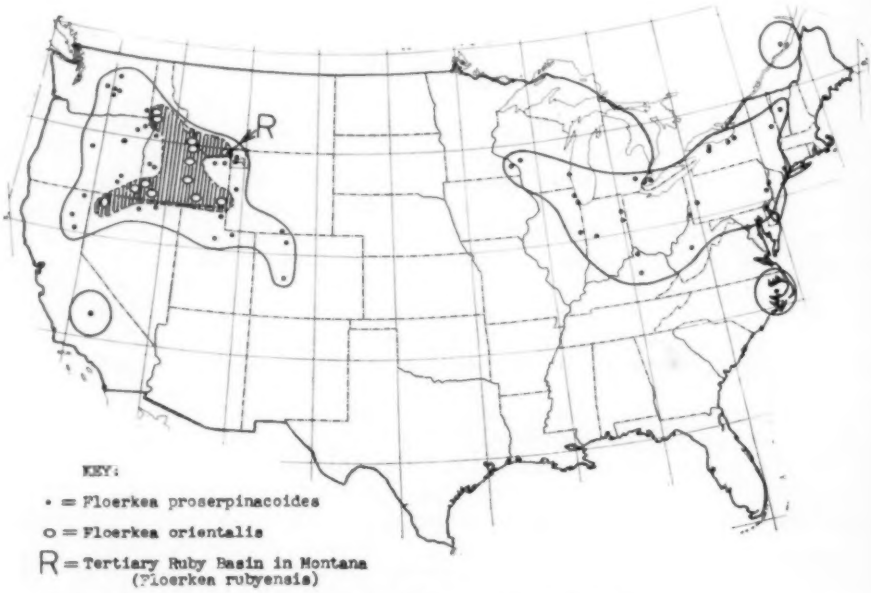


FIG. 1. Regional distribution of *Floerkea* in the United States.

The upper Ruby Basin, a structural trough between the pre-Cambrian Ruby and Gravelly Mountains, lies 60 miles northwest of Yellowstone National Park. Extensive benches, bordering the Ruby River in the valley, consist of Tertiary formations of silt, shale, sandstone, and volcanic materials that range from Paleocene to Miocene age. The silt and shale outcrops are highly fossiliferous containing primarily plant and insect fossils, but aquatic invertebrates, fishes, and a bird were also found (Becker, 1960b).

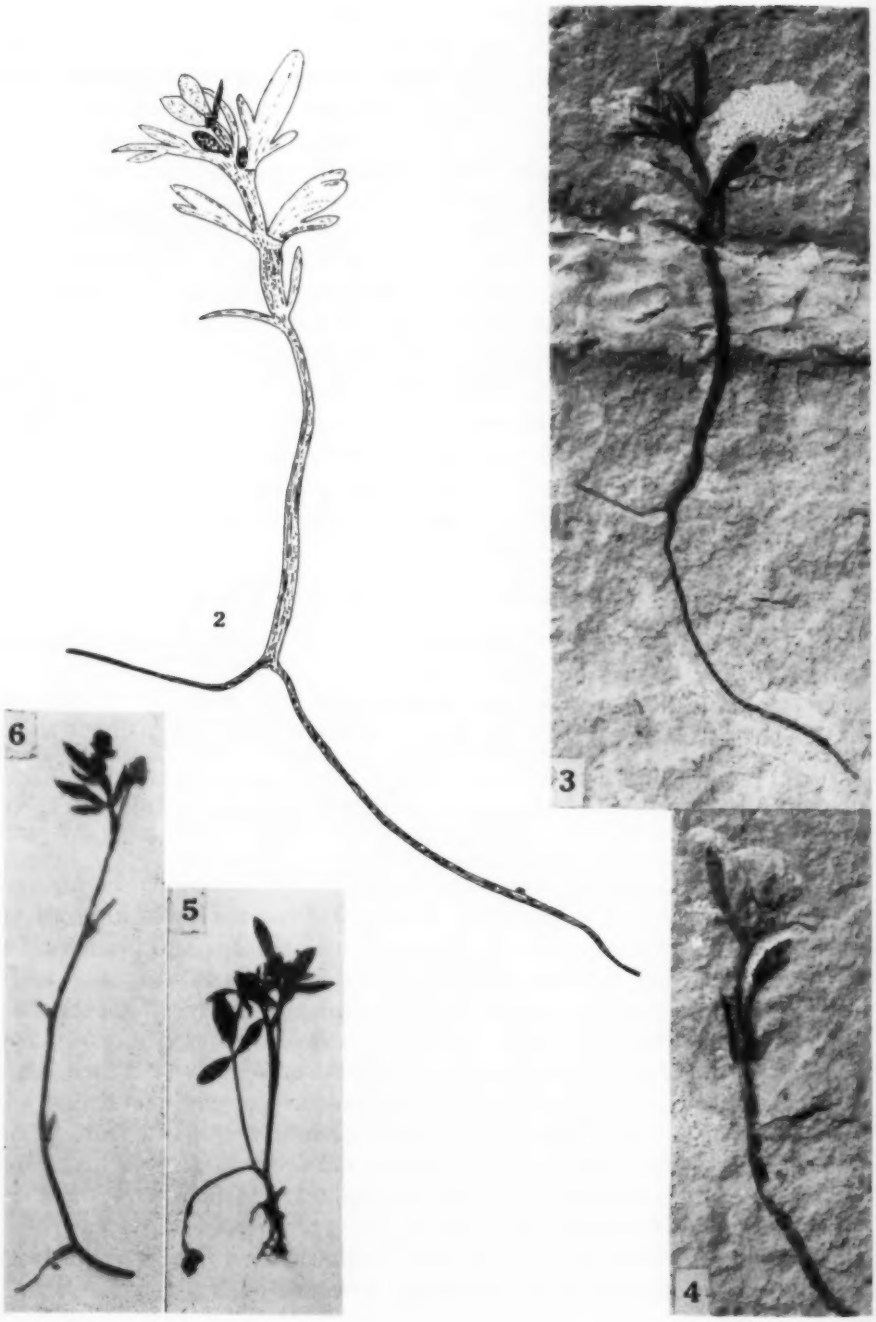
As a result of collections made since 1947, over 150 species of known and new plant fossils described, are collectively known as the "Ruby Flora" (Becker, 1955, 1959, 1960a, 1960b, 1960c). This assemblage comprises elements of Late Lower Eocene (Mormon Creek Flora) and Upper Oligocene (Paper Shale Flora) age. A third unit, the "York Ranch Flora," floristically, lithologically, and in age apparently unrelated, is now under study. Two new families are added to the fossil record, the Cruciferae (*Thlaspi primaevum* Becker, 1960b) and the Limnanthaceae (*Floerkea rubyensis* n. sp.) presented here, both from the Upper Oligocene paper shales. In addition to one new species of *Mahonia* (*M. peloronta*) here presented, several specimens of recently discovered fruiting structures are re-introduced because of supplementary morphological features that will give a better diagnosis of existing types. These fruits and samaras of *Dipteronia, Eucommia, Ulmus,* and *Thlaspi* from the extremely fine-grained paper shales exhibit a detail more faithful and superior to that of any in previously published figures. A recently discovered seed pod of *Astragalus wilmattae* (Cockerell) LaMotte (*Phaca wilmattae* Cockerell) in the shales of the Ruby Basin is re-described.

SYSTEMATIC DESCRIPTIONS

Family LIMNANTHACEAE. Genus *Floerkea* Willdenow. **Floerkea rubyensis** n. sp. (Figures 2, 3, 4).

Description—plant herbaceous, slender, somewhat fleshy; stem sinuous, 2.2 cm. long; root forked, 3.2 cm. long; leaves clustered along upper third of stem, opposite, 3 to 5 mm. long, simple to pinnate with 2 or 3 divisions (leaflets); divisions linear, entire, oblong to oblanceolate or bifurcate; midrib faintly discernible; secondary veins, where present, few, weak, ascending; penduncle 1.5 mm. long; carpels 2, ovate, 1.1 mm. long, 0.6 mm. in diameter; buds sessile, 0.9 mm. long, 0.7 mm. in diameter.

Remarks—The imprint resembles superficially a fragile, herbaceous seedling, but upon closer inspection reveals fruiting bodies in a crown of clustered leaves. A suggestion of relationship to the Limnanthaceae (Maguire, 1960) proved fruitful in that the fossil compares most favorably with mature plants of the living *Floerkea proserpinacoides* Willdenow, or *F. occidentalis* Rydberg (1900). The latter is described as a very slender, glabrous annual, somewhat fleshy, with a simple or slightly branched stem, less than one dm. high, ascending or decumbent. The glabrous leaves are 1 to 3 cm. long, pinnate with 1 to 2 pairs of leaflets, or 3 to 5 divisions that are oblong to oblanceolate to nearly linear, and are 5 to 15 mm. long. The peduncles are 1 cm. long, the carpels, usually 2, are globose, 2 to 5 mm. in diameter with small, pyramidal tubercles. Its type locality is given as Swan Lake in Yellowstone National Park, and its distribution in wet places from Wyoming and Colorado to California and Washington.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The pentamerous, but occasionally tetramerous *Floerkea proserpinacoides Willdenow* (1801) is nearly identical with the trimerous, but sometimes also tetramerous *F. occidentalis*, except for a generally larger size (1 to 3 dm.) of most structures. Its type locality in wet places and meadows is Pennsylvania with a range from Quebec to North Dakota, Tennessee, Delaware, and the Alleghenys. Russell (1920) suggests that *F. occidentalis* is probably a "starved or feeble form of *F. proserpinacoides* of varietal rank," a statement that may apply to specimens of *F. occidentalis* occurring at high altitudes as shown in Fig. 1. *F. occidentalis* may be a "condensed" form that Piper (1906) considers merely a reduced type of *F. proserpinacoides*. Leroy Abrams (1951) synonymizes *F. occidentalis* with *F. proserpinacoides*, although in his general description he fails to incorporate the smaller size value of *F. occidentalis*. Lawrence (1951) and Mason (1952) consider the genus monotypic. In the absence of more distinct morphological characters between the two purported species a synonymy seems justifiable since range of variability in size alone can hardly be considered a specific criterion. A compilation of localities for both species according to counties, as available from herbarium sheets at the New York Botanical Garden (fig. 1), demonstrates one clustering of *F. proserpinacoides* in the eastern United States, and a second clustering in the northwestern States. The northwestern distributional area for *F. proserpinacoides* encloses a unit of predominantly smaller *F. occidentalis* at altitudes from 6000 to 9800 feet, a fact which by climatic implication may have been the reason for the separation into two species.

The new fossil, in its general appearance and size (fig. 3) compares favorably with *F. occidentalis* (figs. 5, 6) which is also found on wet ground on the western slope of the Gravelly Range, bordering the upper Ruby basin only 5 miles from the fossil sites. It was conclusively shown (Becker 1960b, 1960c) that there were ample "wet" places along the Tertiary Ruby lake where *Floerkea* could have existed, and it is therefore quite possible that *Floerkea* has been present in this area without interruption since the Oligocene. The absence of *Floerkea* in the fossil record so far may be explained in its matted growth habit and delicate structure that are not conducive to preservation. *Floerkea rubyensis* represents the first occurrence of the family Limnanthaceae in the fossil record. The generic name commemorates the German botanist H. G. Floerke (1746–1835).

Material.—Holotype, N. Y. Bot. Gard. 1RPS.

FIGS. 2–6. FIG. 2. *Floerkea rubyensis* n. sp. Structural detail of entire plant, × 2½; FIG. 3. *Floerkea rubyensis* n. sp. Holotype, N.Y.B.G. 1RPS, × 1¾; FIG. 4. counterpart of holotype; FIG. 5, 6. *Floerkea occidentalis* Rydberg. Living species for comparison with *F. rubyensis*, × 1; N.Y.B.G. Herbarium.

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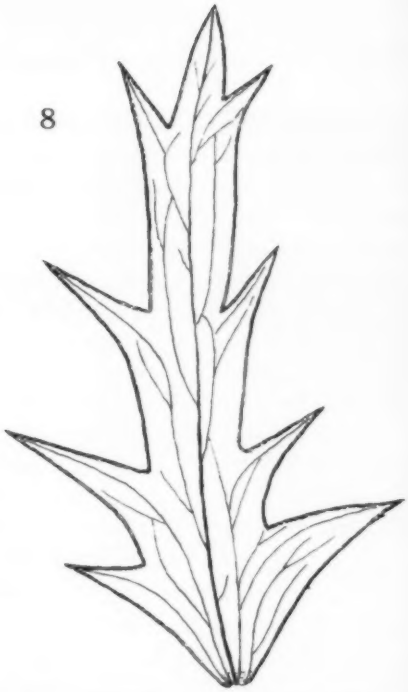


Family BERBERIDACEAE. Genus *Mahonia* Nuttall. **Mahonia peloronta** n. sp. (Figures 7, 8).

Description—Leaflet narrowly elongate, inaequilateral, 6 cm. long, 3.4 cm. wide (tip to tip of lower teeth), deeply dentate; base asymmetrically cuneate; apex an acute, terminal tooth, 8 mm. long; teeth 4 pairs, subopposite, elongate-triangular, sharply spinose, 5 to 14 mm. long with length-width ratio of 2:1; sinuses angular to slightly rounded from 60° to 90°; lamina of blade 10 mm. wide above basal pair of teeth, tapering to 7 mm. below 4th pair, to 3.5 mm. below terminal tooth; midrib weak, slightly curved; basal primary veins 4, weak; adaxial primaries paralleling midrib, entering second pair of teeth; abaxial primaries bifurcating, entering basal

TABLE 1.

		MAHONIA PELORONTA	*MAHONIA LOBODONTA*
Leaf:		?	3-pinnate
Leaflet:			
	shape	elongate, inaequilateral	elongate, inaequilateral
	length	6 cm.	4 cm.
	width	3.4 cm.	2.5 cm.
	margin	normal	thickened
	base	inaequilateral, straight	inaequilateral, concave
Teeth:			
	number	(9), 4 pairs	(5), 2 pairs
	structure	elongate, deltoid	elongate, lobed
	length	5 to 14 mm.	10 to 13 mm.
	margin	straight	curved
	apex	spinose, 8 mm. long	spinose ?, 12 mm. long
	length-width ratio	2:1	2½ to 3:1
Sinuses:		60° to 90°	60° to 100°
Blade:	width	10 – 7 – 3 mm.	9 – 7 – 4 mm.
Venation:			
	midrib	weak	strong
	basal primaries prominent	4, weak	2, strong
	secondaries	3 pairs	1 pair
	major mesh	elongate-longitudinal	elongate-longitudinal
Texture:		coriaceous	coriaceous

pair of teeth; axial secondary veins 3 pairs, alternate, arising at low angle, paralleling midrib for short distance, branching and entering teeth; major mesh elongate-polygonal, generally parallel to axis; ultimate areolation indistinct; texture coriaceous.

Remarks—*Mahonia peloronta* is unlike any other species previously described, although it exhibits some characters that point to a relationship with *M. lobodonta* Becker (1959). Other diagnostic features, however, warrant separation as shown in the comparative table:

FIGS. 7–10. FIG. 7. *Mahonia peloronta* n. sp. Holotype, N.Y.B.G. 5RPS, ×1½; FIG. 8. *M. peloronta* n. sp., structural detail of leaflet; FIG. 9. *Astragalus wilmattae* (Cockerell) LaMotte. Hypotype, N.Y.B.G 6RPS (seed pod) ×6½; FIG. 10. counterpart of hypotype.

Structural similarities common to both species, suggesting taxonomic kinship, is expressed in the elongate, spinose teeth, and the pattern of venation, but differences outweigh by far their superficial similarity. *Mahonia peloronta* is considerably longer, more slender, and has a greater number of teeth that are narrowly deltoid and sharply spinose. Its weak midrib, four basal primary veins, and three pairs of axial secondary veins stand in sharp contrast to equivalent structures in *M. lobodonta*. The vague similarity of *M. lobodonta* to *M. trifoliata* Fedde holds even more tenuously for the new species (Table 1).

Material.—Holotype, N.Y.B.G., 5RPS.

Family LEGUMINOSAE. Genus *Astragalus* Linnaeus. *Astragalus wilmattae* (Cockerell) LaMotte (Figures 9, 10).

Astragalus wilmattae (Cockerell) LaMotte, 1952. Catalogue of the Cenozoic plants of North America through 1950, p. 79.

Phaca wilmattae Cockerell, 1908. Descriptions of Tertiary plants, Amer. Jour. Sci., vol. 26, p. 67, text fig. d (inverted) p. 66. MacGinitie, 1953. Carn. Inst. Wash. Publ. 599, p. 125, pl. 29, fig. 4

A well preserved leguminous pod with counterpart duplicates in every detail the holotype (*Phaca*) from the Florissant beds in Colorado. MacGinitie (1953) states that "the genus (*Phaca*) must be considered tentative, since there are other legumes in addition to *Phaca* (*Astragalus*) which have very similar pods." LaMotte (1952), without additional substantiating information, changed the name to *Astragalus wilmattae*. There is no doubt that the Ruby and Florissant (holotype) specimens are identical, but whether or not they are *Astragalus* remains open to question until more diagnostic material is available. In the N. Y. Botanic Garden Herbarium all living *Phaca* are transferred to *Astragalus*, and the *fossil* is indeed similar to pods of the living *Astragalus litvinovianus Gontscharov*. Cockerell compares the Florissant specimen in form to *Phaca longifolia* (Pursh) Nuttall and in its pedunculate state to *Phaca americana* (Hooker) Rydberg. The following diagnostic data pertain to the Ruby hypotype as compared with the Florissant holotype (in parenthesis), and they show that differences other than minor dimensional variations do not exist

Pod symmetrically broad-ovate; overall length 16 mm (19 mm); length of pod 12 mm (14 mm), width 8 mm (10 mm); stipe 1.5 mm (2 mm) long, abruptly attached to base of pod; peduncle and hypanthium 2 mm (2 mm) long, cup-shaped, 1.8 mm wide with sepal and petal scars; style and stigma 2.5 mm (3.5 mm) long, sharply curved.

Discovery of *Astragalus wilmattae* in the shales of the Ruby flora not only adds an additional species to the homotaxial overlap between it and the Florissant flora, but represents a species previously unique to Florissant. *A. wilmattae*, together with *Cotinus fraterna*, *Fagopsis longifolia*,

Mahonia obliqua, *Populus crassa*, and *Philadelphus parvulus*, all formerly unique to Florissant (Becker, 1960b), are now identified for the Ruby flora as well. The addition of *Astragalus wilmattae* strengthens the floristic ties indicated previously (Becker, 1960b) by these species that combine the two widely separated floras in a common botanical province.

Material.—Hypotype, N.Y.B.G. 6RPS.

Family ACERACEAE. Genus *Dipteronia* Oliver. *Dipteronia insignis* (Lesquereux) Brown (Figure 11).

Dipteronia insignis (Lesquereux) Brown, 1936 U. S. Geol. Survey Prof. Paper 186, p. 181, pl. 59, figs. 10, 11. MacGinitie, 1953. Carnegie Inst. Wash. Publ. 599, p. 142, pl. 58, fig. 3. Becker, 1960b. Geol. Soc. America, Mem. (in press).

The samara here figured serves to supplement the description and figures of *Dipteronia insignis* from the Ruby paper shale flora. The new specimen reveals superior detail to the types (counterparts) previously figured (Becker, 1960b, pl. 24, figs. 20, 21) and is nearly identical with a samara of the living *D. sinensis* Oliver as shown by Brown (1936, pl. 59, fig. 13).

Material.—Hypotype, N.Y.B.G. 4RPS.

Family EUCOMMIACEAE (TROCHODENDRACEAE). Genus *Eucommia* Oliver. *Eucommia* browni Becker (Figure 12).

Eucommia browni Becker, 1960b. Geol. Soc. America, Mem. (in press).

Following the original description of *Eucommia browni* Becker, several additional specimens were found at various fossil sites that are identical with previously collected samaras of the paper shale material. Among these, one specimen, however, is structurally superior to any other, especially in regard to the width of the peripheral wing and the embryo with the prominently veined cotyledons. These additional finds dispel any doubt as to their specificity compared with R. W. Brown's earlier species, *E. montana* Brown (1940), and *E. eocenica* (Berry)Brown (1940).

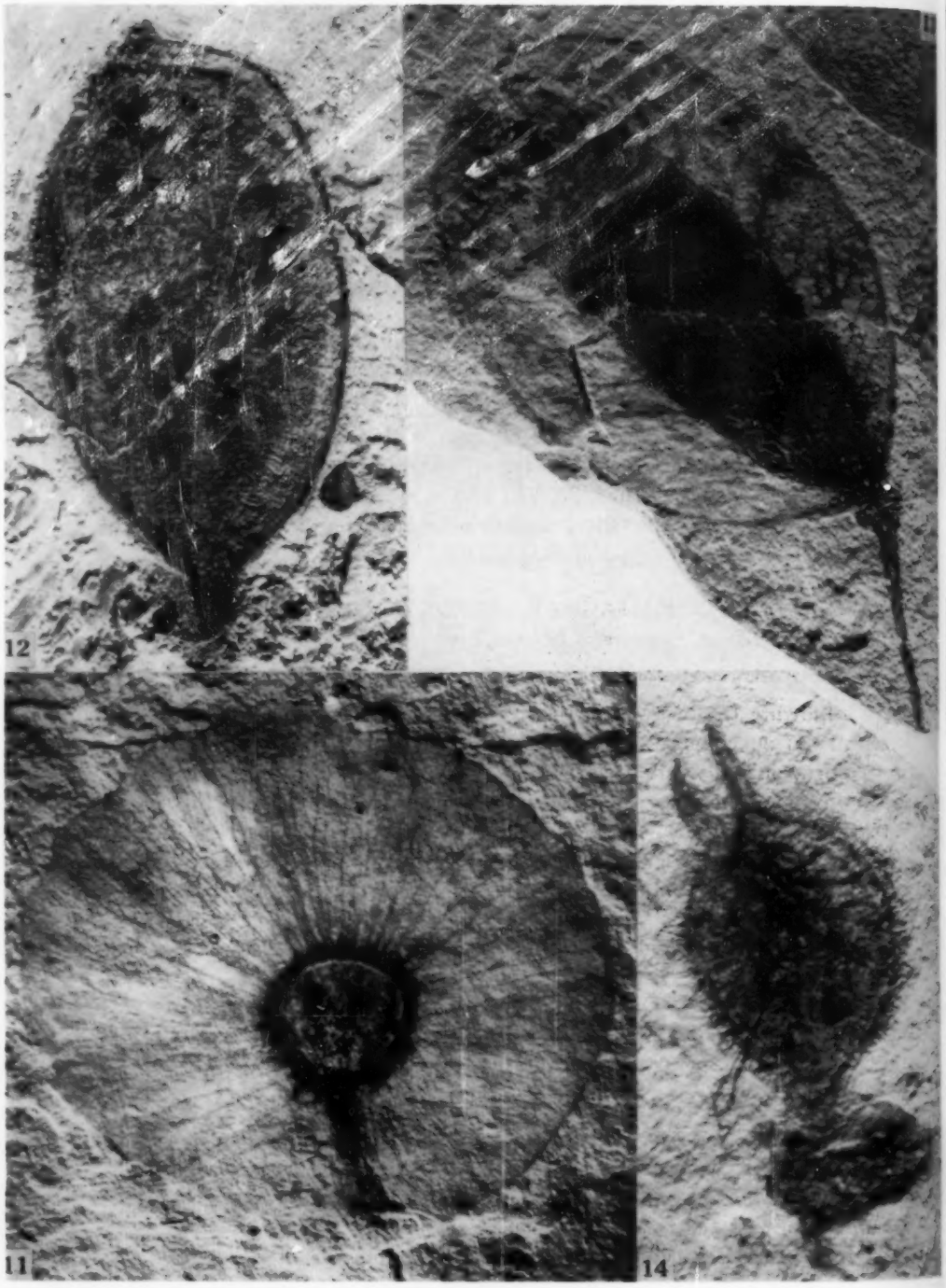
Material.—Paratype, N.Y.B.G. 3RPS.

Family CRUCIFERAE. Genus *Thlaspi* Linnaeus. *Thlaspi primaevum* Becker (Figure 13).

Thlaspi primaevum Becker, 1960b. Geol. Soc. America, Mem. (in press).

With the discovery of fruits of *Thlaspi* in 1957, the family Cruciferae was added to the fossil record. Unfortunately no additional specimens were found in 1959, but the new figure (×7) serves to emphasize morphological detail, and incidentally unite the Cruciferae and the Limnanthaceae, as families new to the fossil record, in this report.

Material.—Holotype Univ. Mich. Mus. Paleont. 38256.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Family ULMACEAE. Genus *Ulmus* Linnaeus. *Ulmus* sp. Becker (samara) (Figure 14).

Ulmus sp. Becker, 1960b. Geol. Soc. America, Mem. (in press).

On the basis of leaf impressions 3 species of *Ulmus*, together with 2 types of samaras, were recognized in the Ruby paper shale flora (Becker, 1960b). Since the samaras are detached, they were not specifically assigned. Among the numerous references to fossil elm samaras in the literature, not one shows surficial or peripheral velutinous vesture. In several of the specimens, however, that were collected at Ruby sites No. 2 and No. 10 in 1959, such marginal hairs are clearly discernible. They are closely spaced, tapering sharply, terminally colorless, and approximately 0.4 mm. long. Samaras of the living *Ulmus thomassii* Sarg. (*U. racemosa* Thomas), previously figured (Becker), are similar in this respect. Although not specifically identified, the new fossil specimen adds an important characteristic to earlier material.

Material.—Paratype, N.Y.B.G. 2RPS.

SUMMARY

Two new plant species from the Upper Oligocene Ruby Paper Shale Flora of the upper Ruby River Basin in southwestern Montana are here described. *Mahonia peloronta* n. sp. of the family Berberidaceae appears to be related to *M. lobodonta* Becker. *Floerkea rubyensis* n. sp. represents the first fossil record for the family Limnanthaceae. *Astragalus wilmattae* (Cockerell) LaMotte is presented as new to the fossil Ruby record; additional detail of morphological structures is recorded for the following previously reported fossils of *Dipteronia insignis* (Lesquereux) Brown, *Eucommia browni* Becker, *Ulmus* sp. Becker, and *Thlaspi primaevum* Becker.

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FIGS. 11–14. FIG. 11. *Dipteronia insignis* (Lesquereux) Brown. Hypotype, N.Y.B.G. 4RPS, (samara) ×5; FIG. 12. *Eucommia browni Becker.* Paratype, N.Y.B.G. 3RPS, (samara) ×14; FIG. 13. *Thlaspi primaevum* Becker. Holotype, Univ. Mich. Mus. Paleont. 38256, (fruit) ×7; FIG. 14. *Ulmus* sp. Becker. Paratype, N.Y.B.G. 2RPS, (samara) ×7.

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NOTES ON GILBERTELLA PERSICARIA FROM CALIFORNIA

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During the summers of 1958 and 1959 an unknown member of the Mucorales was isolated several times from decaying peach fruits (*Prunus persica* Batsch.) near Fresno and Yuba City and once from a tomato fruit (*Lycopersicon esculentum* Mill.) at Davis, California. The sexual and asexual reproductive structures were similar to species of the genus *Mucor*, except for the presence of appendaged sporangiospores (Fig. 1, A).

After work on the taxonomy of the unknown was nearly completed, the writers obtained a manuscript, then in press (Hesseltine 1960), from Dr. C. W. Hesseltine which seemed to describe our fungus. This notion was confirmed by a comparison of California cultures with those obtained from Dr. Hesseltine, and the Jacobs culture of *Choanephora persicaria* Eddy designated as the type culture of *Gilbertella persicaria* by Hesseltine (1960). Also, Hesseltine examined the cultures obtained from peach in California and agreed that it was the same organism that he had described. He placed the fungus in the new genus *Gilbertella* Hesseltine and designated the species as *G. persicaria* (Eddy) Hesseltine.

The purpose of the present paper is to report additional observations on *G. persicaria* based upon collections made in California.

Appendages. The appendages are clearly visible on sporangiospores obtained from potato-dextrose agar (PDA) if observations are made with a phase-contrast microscope or if an aqueous suspension of spores is first air dried on a slide prior to staining with 0.1% Crystal violet in 5.0% glycerine.

A number of biological stains failed to stain the appendages: 0.4% Cotton blue in Lacto-phenol; 0.05% Acid fuchsin in Lacto-phenol; 1.0% aqueous Safranin-O; 0.1% Resorcin-blue in 50% ethanol; and IKI. A weak staining reaction was obtained with 0.2% Orcein in 6.0% acetic acid.

The electron microscope was employed to view the arrangement and structure of appendages. An aqueous suspension of sporangiospores from PDA was pipetted on collodion-coated, 200-mesh nickel electron microscope grids, air dried, shadowed with uranium at a 30-degree angle, and examined with an RCA EMU-3 electron microscope.

Appendages are single (Fig. 1, A) or once-branched (Fig. 1, C) and arise from a common point at each pole of the spore. They appear ribbon-like, about 0.18μ to 0.2μ wide, with longitudinal ridges. Appendages may split lengthwise between the ridges (Fig. 1, A, lower left) to produce filaments about .05μ wide.

Mating Reactions. Of the twenty-five single-spore cultures tested, 14

were determined to be plus (+) and 11 the minus (−) mating type. California cultures of appropriate mating type produced strong lines of zygospores when mated with cultures A7313, NRRL 1546, and NRRL 2352 obtained from Hesseltine (1960). California-plus isolates also formed zygospores when mated with *Choanephora persicaria* Eddy obtained from Centraal-

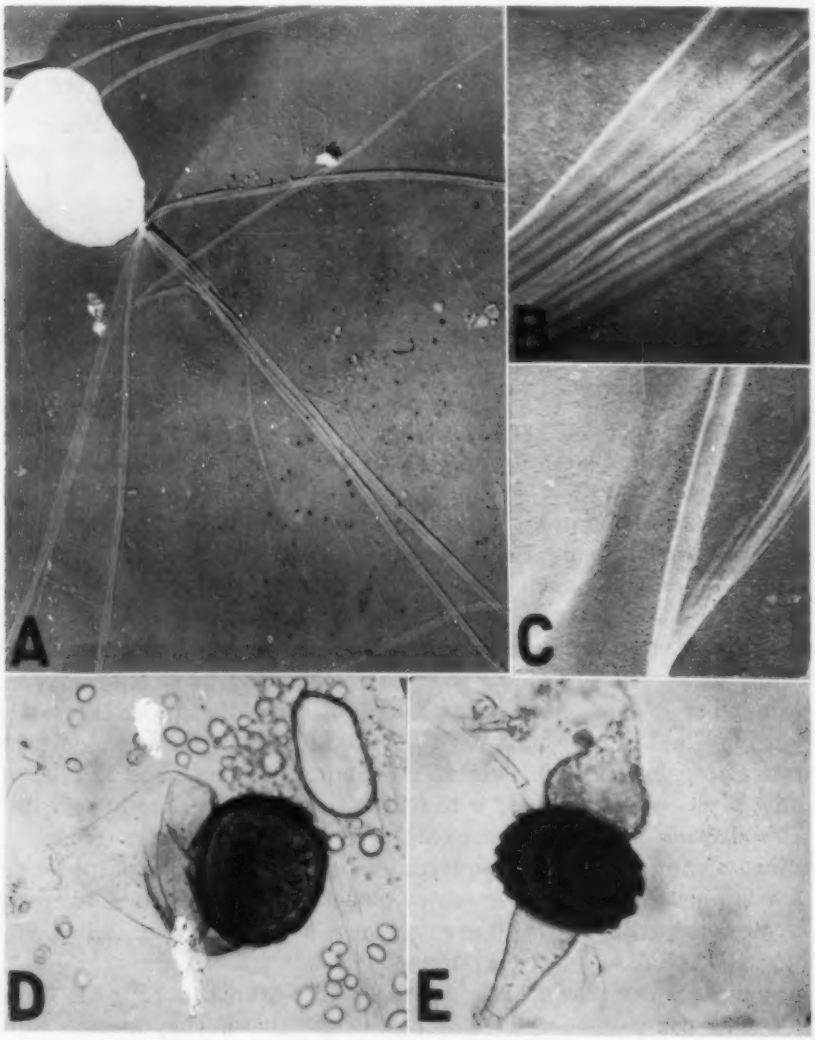

FIG. 1. A–E, Electron micrographs of appendages of *G. persicaria*. A. Sporangiospore with attached appendages. × 5200. B. Portions of appendages showing ribbed nature. × 31,000. C. Branching of an appendage near point of origin from the spore. × 19,500. D. Zygospore formed in mating of *G. persicaria* (+) with *Rhizopus stolonifer* (−). E. Zygospore of *G. persicaria*. × 220.

bureau voor Schimmelcultures (CBS). The latter culture is listed by Hesseltine (1960) as NRRL 2700.

In an attempt to determine possible relations with other members of the Mucorales, plus and minus strains of *G. persicaria* were paired in Petri dishes on PDA in darkness at 25°C with the following fungi: *Mucor griseocyanus* Hagem (+) and (−) strains; *M. circinelloides* Van Tieghem; *M. jansseni* Lendner; *M. saturninus* Hagem; *M. indicus* Lendner; *M. recurvus* Butler; *M. spinosa* Van Tieghem; *M. hiemais* Wehmer (+) and (−) strains; *M. mucedo* Bref.; *Choanephora cucurbitarum* (B. et Rav.) Thaxter (+) and (−) strains; *Blakeslea trispora* Thaxter (+) and (−) strains; *Rhizopus stolonifer*[1] (Ehr. ex Fr.) Vuillemin (+) and (−) strains; *R. thermosus* Yamamoto; *R. tonkinensis* Vuill.; *R. tritici* Saito; *R. arrhizus* Fischer, *R. chinensis* Saito, and *R. oryzae* Went. et Pr. Geerl.

Matings of *G. persicaria* with all species of *Mucor* and with *Choanephora cucurbitarum* were uniformly negative for the presence of any structures indicative of a sexual reaction. Six California isolates of *G. persicaria* were mated with plus and minus cultures of *B. trispora*. Our results agree with those obtained by Hesseltine (1960) except that zygospores were never formed.

Zygospores were formed, however, when plus cultures of *G. persicaria* were mated with a single culture of *Rhizopus stolonifer*. In this mating only very few mature zygospores (Fig. 1, D) were formed but "progametangia" and "gametangia" developed in abundance in a line between two cultures. Formation of the latter structures occurred when plus cultures of *G. persicaria* were mated with several minus strains of *R. stolonifer* but no visible reaction occurred when minus cultures of *G. persicaria* were mated with plus cultures of *R. stolonifer*.

Although the morphology of the zygospore suspensors is designated as equal in many species of the Mucorales, there may be differences in the shape and size of the two suspensors attached to a given zygospore. Zycha (1935) illustrated this for *Rhizopus nigricans* Ehr. For *G. persicaria* the tendency toward equal suspensors is controlled by the medium. Thus, depending on the culture medium, the suspensors of *G. persicaria* tend to be dissimilar, similar, and equal. On PDA most of the suspensors are of the inequal type illustrated in Fig. 1, E. On V-8 juice agar (Miller 1955) one isolate formed only 23% zygospores with inequal suspensors (Fig. 1, E) while on PDA 82% were heteromorphic. Five mating combinations produced 69% of zygospores with heteromorphic suspensors on PDA and only 36% on V-8 juice.

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[1] Cultures of *Rhizopus* species except *R. stolonifer* were obtained from Centraalbureau voor Schimmelcultures, Baarn, Holland. The authors are indebted to Drs. C. W. Hesseltine, R. K. Benjamin and E. S. Beneke for cultures of other Mucorales.

Phototropism. Sporangiophores of *G. persicaria* from California, unlike the isolates of this fungus observed by Hesseltine (1960) were positively phototropic to white light. This conclusion is based on the results of two experiments. In the first, 19 cultures of *G. persicaria* were transferred in duplicate tubes (PDA) and placed in unidirectional diffuse daylight at 18–25°C. In a second test, 3 plus and 3 minus cultures, on PDA, received unidirectional artificial light from a 15-watt white fluorescent tube placed 30 cm. from the plates. The plates were separated from the light source by the glass door of the incubator where the temperature was maintained critically at 25°C. Incident light, measured with a General Electric PR-1 exposure meter, ranged 48–60 f.c. at the edge of the plates nearest the light. Duplicate plates incubated in darkness showed no phototropic reaction.

The sporangiophores in four of the 19 cultures in the first test bent strongly and uniformly in the direction of the light. In the remaining 15 some sporangiophores were positively phototropic while others were not. All California cultures gave some evidence of phototropism. On the other hand the sporangiophores of the type culture obtained from C.B.S. were insensitive to white light.

Sporangiophores in the light were straight and either oriented toward the light or erect; those in darkness were erect. A few nodding or recurved sporangiophores were observed but they could not be considered typical for the species. This finding is contrary to observations made by Hesseltine (1960).

Discussion. With minor exceptions already noted the isolates of *G. persicaria* from California fit well the description of this species given by Hesseltine (1960). Our findings indicate that only two characters serve to separate *Gilbertella* from *Mucor:* The tendency of the sporangium wall to split more or less into two parts, which then may remain intact; and the presence of hyaline appendages on the sporangiospores. The classification of the fungus considered here depends upon the taxonomic importance given to the latter structures. If the appendages are considered of minor importance, then *Gilbertella* could be reduced to a synonym of *Mucor*. Hesseltine has taken the opposite view, and indeed there is ample precedent in support of the erection of new genera of fungi on the basis of spore appendages.

In any case, in the future it will be necessary for mycologists to treat all Mucor-suspected fungi with a suitable "flagella" stain or examine specimens with the aid of the phase or electron microscope before making a determination.

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EFFECTS OF LOGGING AND FIRE ON XEROPHYTIC FORESTS IN NORTHERN MICHIGAN[1]

PAUL D. KILBURN

Extensive areas of the lake states of Michigan, Wisconsin and Minnesota are covered with xerophytic forest stands which grow on sandy soils of glacial origin. The coarsest of these soils are termed sands, inasmuch as more than ninety percent of their weight is composed of sand grains. Long the subject of intense botanical interest, the vegetation of these dry habitats is composed of several forest types. This paper records man-induced past changes and predicts future succession in these forest types in Cheboygan County, Michigan.

Three distinct forest types occurred on these sands. The first, the jack pine type, consisted principally of small, scrubby jack pines (*Pinus banksiana*)[2], and some larger red pines (*P. resinosa*). The second, the hemlock-pine type, was dominated by hemlock (*Tsuga canadensis*), red pine (*Pinus resinosa*), and white pine (*P. strobus*). The third, the pine-oak type, included several dominants, principally red and white pine, red oak (*Quercus rubra*) and white oak (*Q. alba*). Table 1 summarizes the General Land

TABLE 1. *Presettlement composition by percent of vegetation types*

Tree Cited	Vegetation Type		
	Hemlock-Pine	Pine-Oak	Jack Pine
Jack pine	0	0	61
Red pine	26	40	27
White pine	26	15	4
Hemlock	32	6	1
Bigtooth Aspen	4	12	2
White oak	0	19	2
Red oak	6	6	1
Paper birch	6	1	1
Beech	0	1	1
Total	100	100	100
Number of Trees	51	53	206

Office Survey data pertaining to these types. The percent figures were determined from some 310 bearing and line trees recorded in the county survey made between 1840 and 1855 (Kilburn, 1957). This technique is well discussed by Bourdo (1956). It is important to note the presence of big-

[1] Contribution from the Biological Station of the University of Michigan.
[2] Common and scientific names agree with Little (1953).

tooth aspen in all three forest types, for this species has since become dominant in the hemlock-pine type.

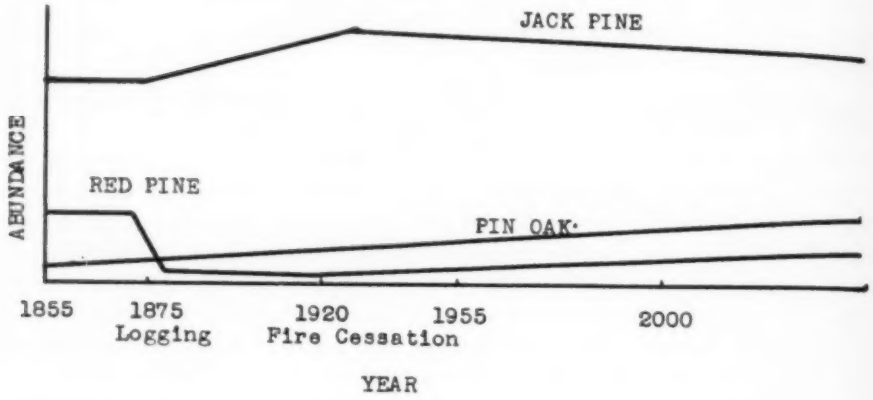
Although settlement of the county is more thoroughly discussed elsewhere (Kilburn, 1960), it is summarized briefly below owing to its effect on the vegetation. Settlement in the county began in 1855 and a population increase continued for about fifty years. Increased logging, which reached its peak in the 1890's, accompanied this population rise. This logging was invariably followed by fire, so that by 1900 the sandy soil vegetation had been logged and burned. Frequent fires continued into the 1920's at which time increased public awareness, federal fire protection, and better roads reduced fire damage markedly. Most areas covered by these three forest types have been undisturbed since that time.

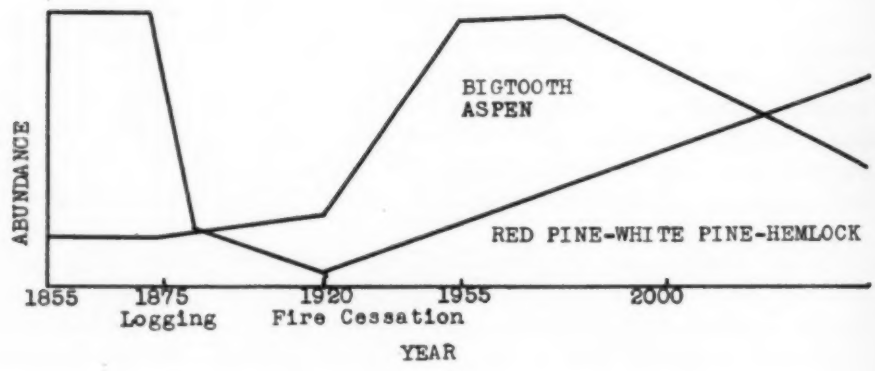
Settlement affected the three forest types differently because logging varied in each type and because each species reacted differently to fire. The jack pine type was least affected by these operations, because jack pine itself was too small for logging, and only red pine was removed from the stands. In addition, heat from fires causes the normally closed seed cones to open and drop their seed. In this way fire favors reproduction of jack pine and has probably always been part of the environment of the species. But the impact of man on the jack pines will become more pronounced in the future, for these stands have recently become a commercial source of wood pulp, and increased logging activities in this type are taking place throughout the state.

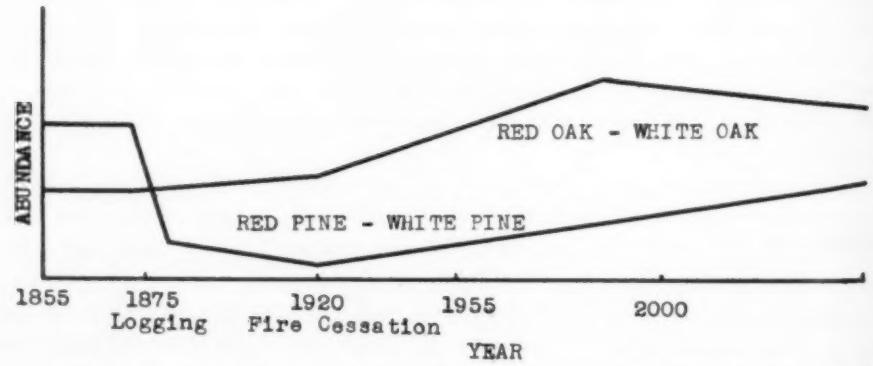
In the hemlock-pine type, red and white pine were logged for their lumber, while hemlock was extracted primarily for its bark, a source of tannin. Logging and subsequent fires eliminated nearly all the seed-bearing adults and destroyed most of the young trees. Hemlock, being especially fire-susceptible, was virtually eliminated from the forest. But where fires were harmful to the pines, and disastrous to hemlock, they were beneficial to bigtooth aspen, whose sprouting and spread were encouraged by cutting and burning. With competition reduced, this clonal plant took advantage of the openings and became the dominant tree. The forest type is now a bigtooth aspen type, with only a few scattered pines and other trees (Gates, 1930).

In the pine-oak type, elimination of the large pines allowed the oaks to grow larger and to fill in the openings caused by logging. Today red and white oak are codominant in these stands and only a few scattered pine seedlings remain.

Summarization of past changes and projection of future trends in the jack pine type are shown in Figure 1. The first change occurred with the logging of the red pine, a change which must have been accompanied by an increase in the amount of jack pine. The second change, one occurring







FIGS. 1–3. FIG. 1 (top) Jack pine type—past and presumed future changes. FIG. 2 (middle) Hemlock-pine type—past and presumed future changes. FIG. 3 (bottom) Pine-oak type—past and presumed future changes.

only in stands with northern pin oak (*Q. ellipsoidalis*), indicates that as fire is eliminated, pin oak increases at the expense of jack pine. Selective logging for jack pine pulp can only hasten this replacement. This apparent trend, however, needs further corroboration.

In the hemlock-pine type, the abrupt effect of logging on the softwoods is illustrated by the marked decline of these trees (Figure 2). Further reduction in numbers of trees took place during the period of recurring fires. During this time the aspen spread out, so when the fires ceased, it rapidly assumed complete dominance of the area. The future of these even-aged aspen stands depends on the natural stocking of pine seedlings, which is surprisingly good in some areas. In these open stands, both red and white pine seedlings grow well and will no doubt dominate in time. This will take from 100 to 200 years in areas where pine seedlings are found, and even longer where no seedlings are present. The reestablishment of hemlock will take much longer than this due to the scarcity of seed sources.

The changes in the pine-oak type also show an abrupt decrease in the amount of pine after logging (Figure 3). The post-logging fires damaged, but did not kill, the larger oaks, so that they are now completely dominant. In the future, the successional trend will be directed toward reestablishment of the presettlement pine-oak ratios. This will require at least 200 years where pine seedlings now exist and longer in many areas where they do not.

The impact of man on these forests has been pronounced, and although these types will tend to revert to their former condition, it is probable that permanent changes will result. Hemlock may never regain its position in the hemlock-pine type, and the jack pine type will probably be reduced in area as oak replaces pine under present fire protection. It is suggested that man's future management of these and similar areas consider the results apparent in this county.

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CYTOLOGICAL AND MORPHOLOGICAL INVESTIGATIONS IN RAFFLESIA ARNOLDI R. BR.

L. V. OLAH

The first specimen of the unique parasitic genus of flowering plants, *Rafflesia* Robert Brown, was discovered in 1818 in the region of Bencoolen, at Pulo Lebar, by Raffles and Arnold. It was described by Robert Brown (1822) and named *Rafflesia arnoldi* R. Br. Since this early discovery, various other findings have been reported from Central and Southern Sumatra. However, inexact observations, incomplete illustrations, and controversial descriptions have created some confusion and uncertainty about the recent existence of the original type collected by Raffles and Arnold.

According to Koorders (1918), the *Rafflesia* genus comprises 13 species.

Recently, Meijer (1958) reviewed the previous findings on *Rafflesia arnoldi* and critically compared them with the newly collected specimens. He pointed out that all the recently located habitats in Central and Southern Sumatra have only one species. This species is considered by Meijer as conspecific with the original type of *Rafflesia arnoldi*.

Rafflesia arnoldi is an endemic species in Sumatra. However, *R. tuanmudae* Becc., collected in Borneo, seems to be closely related to *R. arnoldi*.

In the *Rafflesia* genus only one species, *R. patma* Bl., has been investigated cytologically. Ernst and Schmid (1909 & 1913) were able to collect 50 specimens of this small and rather common species on the island Noesa Kambangan, which is located close to Java. The development of the embryo sac and of the pollen grain was described. The chromosome number was established as n = 12.

Since *R. arnoldi*, the largest species, was never investigated cytologically. a field expedition was organized by the author, in order to collect specimens for cytological research. In December of 1955 the following places in Central Sumatra were visited: Padang, Padangtinggi, Setia Mulia, Kajuaro, Bukittinggi, the Nature Reserve of Batang-Palupuh, Pajakumbuh, Padangmengatas, and Halaban on the slope of the Volcano Gunnung Sago.

The *Rafflesia* habitats were found in the jungle near Padangtinggi (7 buds), in the Nature Reserve of Batang-Palupuh (23 buds), and in the jungle near Halaban along the creek, Sungur Tibur (24 buds, 1 flower, and several wilted flowers and fruits).

Although the total number of the located specimens was approximately sixty, great difficulties were encountered in collecting suitable material for cytological investigation. *Rafflesia* is strictly protected, so special permission was needed to collect it. This permission stipulated the number of buds that

could be removed. The primary project was to collect male buds in early developmental stages. *Rafflesia* is dioecious and the female bud is indistinguishable from the male bud before anthesis. Therefore the buds had to be removed and dissected to determine the sex. The removal of the buds from the vine of the host may seriously affect the development of the other buds located on the same host plant. In addition information was not available to indicate the relationship between bud size and stage of division, consequently we had to collect buds of different sizes.

In the jungle near Padangtinggi 3 buds were collected from the 7 found. In the protected Nature Reserve 23 buds were under observation as a part of a study and their development was measured periodically by the local forest service. Therefore, in this habitat only 1 bud was collected. In the third habitat, along the creek Sungur Tibur, near Halaban (located by Meijer), 7 buds, 1 flower, and several fruits were collected. Of these 11 buds collected 5 were male, 3 female, and in three the sex was not determined.

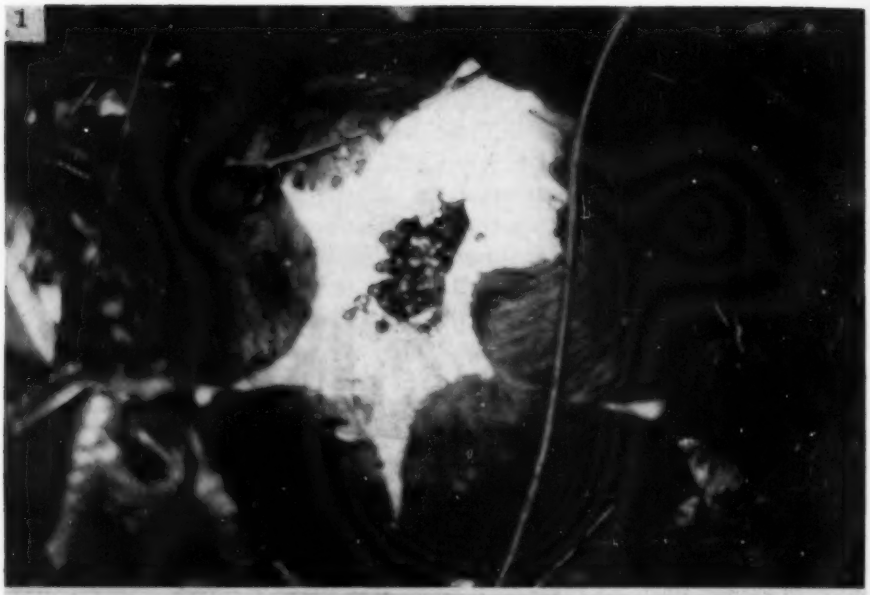
The author is indebted to Dr. W. Meijer for the assistance given during the field expedition, to Dr. A. G. L. Adelbert for the identification of the bud used for cytological study, and to R. Sumersono for drawing the figures. The author also wishes to thank the Botany Department and the Graduate School of Southern Illinois University for the facilities granted to conclude this paper.

Materials and methods. The size of the collected buds, sex and the stage of maturation in the male buds are presented in Table 1. Preliminary in-

TABLE 1. *Locations, sex and size of* Rafflesia *buds and their maturation stage*

No.	Locations	Sex	No. of anthers	Diameter of buds	Height of buds	Stage of pollen development
1.	Padangtinggi	?	—	4.0 cm.	3.0 cm.	————
2.	"	?	—	6.0 cm.	5.0 cm.	————
3.	"	male	40	14.5 cm.	13.5 cm.	P. G. mitosis
4.	Batang Palupuh	female	—	13.5 cm.	13.5 cm.	————
5.	Halaban	female	—	10.8 cm.	8.0 cm.	————
6.	"	female	—	15.0 cm.	12.5 cm.	————
7.	"	male	40	10.0 cm.	8.2 cm.	Sporogenous tissue
8.	"	male	41	15.8 cm.	11.5 cm.	Pollen tetrads
9.	"	male	40	13.7 cm.	11.0 cm.	Leptotene
10.	"	male	40	10.0 cm.	8.5 cm.	Sporogenous tissue
11.	"	?	—	3.8 cm.	3.3 cm.	————

vestigations showed that undifferentiated sporogenous tissue was present in the anthers of buds Nos. 7 and 10. The onset of the meiotic division (early leptotene) was found in bud No. 9, pollen tetrads in bud No. 8, and first haploid mitosis in bud No. 3. Some of the anthers of these buds were fixed in Carnoy fixative and some in Carnoy followed by Karpechenko fixative. Chunks of the ovary of the female buds were fixed in FAA and preserved



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in 70% alcohol. The anthers fixed in Karpechenko were embedded in paraffin and sectioned at 16 and 20 microns. The stains used for the sectioned material were: La Cour's gentian violet, Feulgen, and Feulgen combined with light green. The stain used for the tapetum cells was 2% fast green, dissolved in a mixture of clove oil and 95% alcohol. The anthers fixed in Carnoy were stained in acetic-orcein and aceto-carmine.

Observations and discussion. Table 1 shows the relation between the maturation process and bud size.

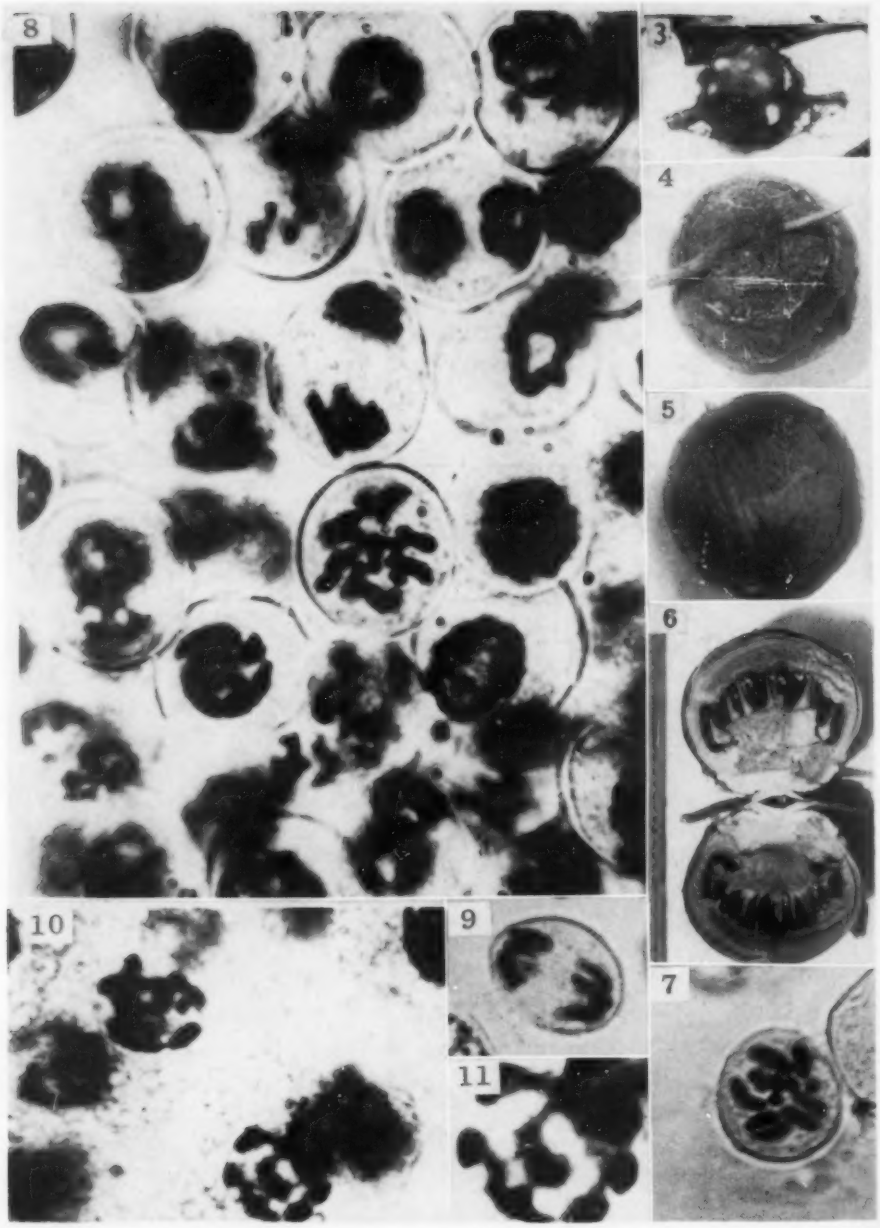
The buds which were 10 cm. in diameter and 8.2–8.5 cm. in height had undifferentiated sporogenous tissue. Early leptotene occurred in a larger bud measuring 13.7×11.0 cm. The end of the meiotic division, marked by the appearance of pollen tetrads, was observed in a bud measuring 15.8×11.5 cm. The first haploid mitosis appeared in the bud of 14.5×13.5 cm. Although the diameter of this bud was 1.3 cm. less than the bud in which a considerably earlier stage (pollen tetrads) was found, its total volume was not less because of its greater height. These data indicate that the meiotic division may occur in those buds which are approximately 13–15 cm. in diameter and 11–12 cm. in height.

The measurements, carried out by the local forest service in Batang-Palupuh, have shown that the development of the buds is extremely slow and the size of the buds, before anthesis, is variable. The same is also true for mature flowers. Meijer (1958), who supervised the measuring, found that a bud 1.5 cm. in diameter required 188 days to reach the size of 4 cm., while another bud of 4 cm. required 310 days to reach the fully developed stage (34 cm.), when anthesis occurred. The smallest bud, measured shortly before anthesis, was 25 cm., while the largest was 36.5 cm. in diameter. Meijer, in 1956, found a giant bud (43 cm.) on the slope of Mt. Sago. Unfortunately, this bud was destroyed later by the local inhabitants. The mature flower also shows a corresponding variation in size. The largest flower measured by Meijer was 90 cm. However, the mature flowers usually range between 50–75 cm.

Fig. 1 shows a bud 36 cm. in diameter found before anthesis by the author at Halaban. Fig. 2 shows a mature flower 54 cm. across the perianth lobes, observed by Meijer in Batang-Palupuh. Fig. 18 illustrates the structure of a mature male flower.

Morphology of the buds. In the small round buds the tissues are firmly compacted and more or less undifferentiated. Fig. 3 shows a bud, 6 cm. in diameter, attached to the vine of the host plant. Column, disc, processus, and the rings are not yet differentiated. The bud shown in Figs. 4, 5, and 6

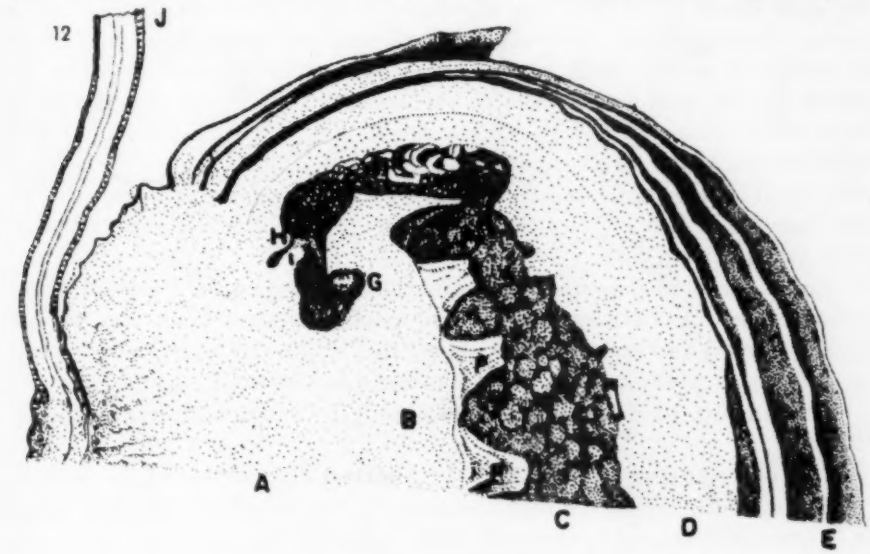
FIGS. 1–2. FIG. 1. Bud of *Rafflesia arnoldi*, fully developed; before opening, about 36 cm. in diameter. FIG. 2. Flower of *Rafflesia arnoldi*, 54 cm. in diameter. Courtesy of W. Meijer.

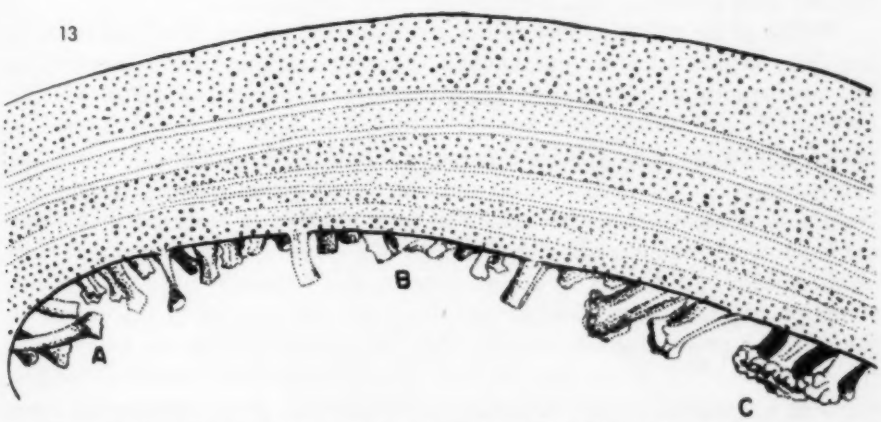


FIGS. 3–11. FIG. 3. *Rafflesia* bud 6 cm. in diameter, attached to the vine of the host plant, *Tetrastigma sp.* FIG. 4. Bud, 14.5 cm. in diameter, bottom view, cupula associated with the vine of *Tetrastigma sp.* FIG. 5. The same bud, top view. FIG. 6. The same male bud cut in half. FIG. 7. Pollen grain in metaphase. Gentianviolet. Approx. × 700. FIG. 8. Pollen grains in division. Gentianviolet. Approx. × 1070. Fig. 9. Pollen grain in anaphase. Gentianviolet. Approx. × 700. FIG. 10. Nuclei of tapetum cells. Gentianviolet. Approx. × 1260. FIG. 11. Structure of chromosomes of resting tapetum nucleus shown in fig. 10. Gentianviolet. Approx. × 2050.

had the internal organs fully differentiated and measured 14.5 cm. in diameter. The reticulated surface of the cupula firmly attached to the vine of the host plant (*Tetrastigma sp.*, Vitaceae) is shown in Fig. 4. The same bud from top view is shown in Fig. 5, with the numerous bracts still covering the bud. Fig. 6 shows the same bud cut in half.

Since the anthers of this bud were used for establishment of the karyotype of *R. arnoldi*, it was necessary to carry out a detailed morphological





FIGS. 12–13. FIG. 12. Radial section through male *Rafflesia* bud, 14.5 cm. in diameter. A column, B disc, C under side of diaphragm, with white wart-like patches, D diaphragm and perianth leaves, E bracts, F mutilated processus, G ring-like fissure under disc, H outer ring, I inner ring, J root of host plant. FIG. 13. Inner side of perianth tube covered with ramenta. Ramenta with swollen apices, B mutilated ramenta, C ramenta with swollen and slightly ramified apices. × 4.

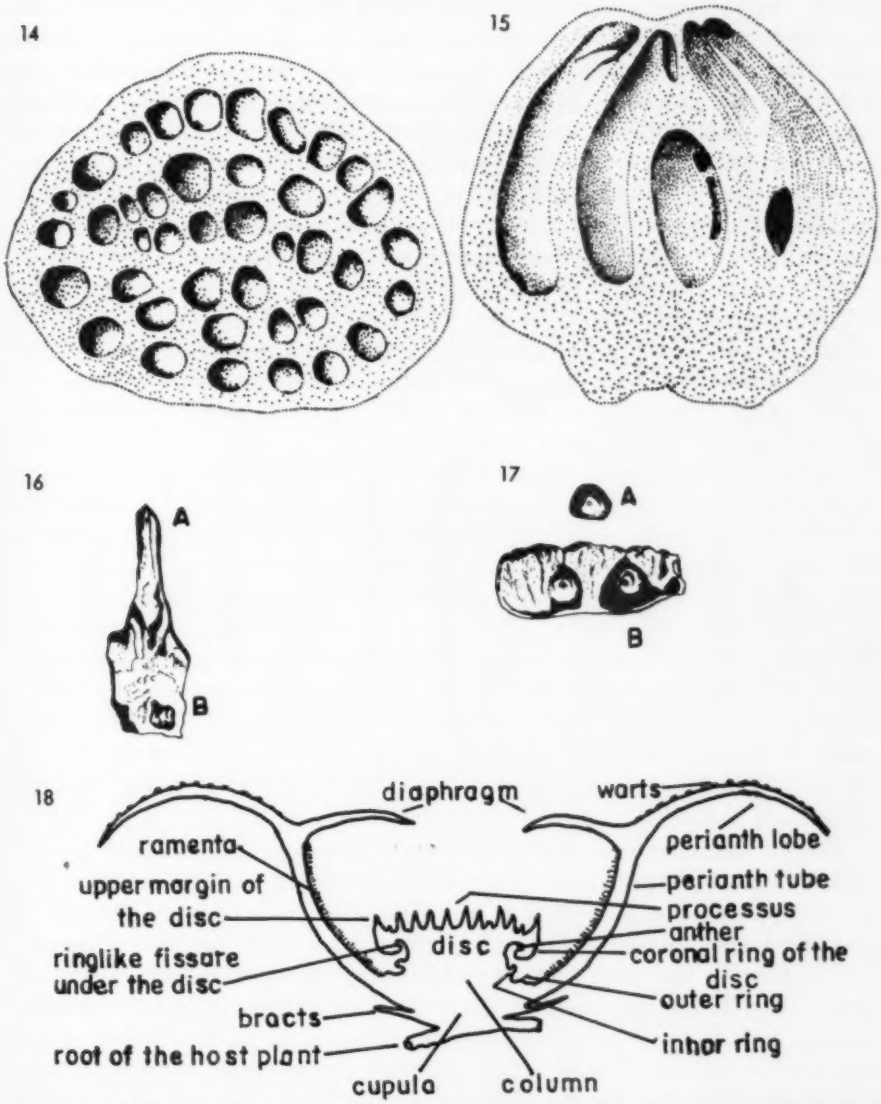
study on this specimen. Fig. 12 shows a longitudinal axial section of this bud. The disc (B) with the processus (F) and the coronal ring of the disc were fully developed. In the ringlike fissure under the disc (G), 40 anthers were located in the anther grooves. The outer ring (H) and the inner ring (I) were well developed and both were very discernible. The presence of both rings is considered as a key characteristic for *R. arnoldi*. However, the outer ring might flatten out during anthesis so that it is hardly detectable in the open flower (Fig. 18). The alteration of this characteristic has caused confusion among taxonomists about the recent existence of *R. arnoldi*. Since *R. arnoldi* is an extremely rare species, most of the taxonomists were not able to obtain buds and flowers at the same time. The key characteristics were mostly obtained by observing a single bud or a single flower so it is understandable that the alteration of the shape of the outer ring was not recognized by most taxonomists. Fig. 13 shows the ramenta with swollen (A) and ramified apices (C) on the inner side of the perianth tube. Some of them are mutilated (B).

Figs. 14 and 15 show the transverse and the longitudinal section of the anthers. About 40 cavities (thecae) are usually present. These cavities are slightly curved and cylindrical as shown in Fig. 15. A single disc processus excised with a portion of the disc containing a portion of an anther groove is shown in Fig. 16. The anther grooves with the anthers are shown in Fig. 17.

This bud was given to Dr. A. G. L. Adelbert Jr., curator of the Botanic Garden of Setia Mulia, for identification. It was described and determined as *R. arnoldi* R. Br., and preserved in 70% alcohol. The drawings were made in the Treub Laboratorium, Botanic Gardens, Bogor, Java.

Pollen-grain mitosis. The pollen grains in the anther cavities are loose, i.e., fully separated from one another. During anaphase the movement of the two groups of chromatids are completely symmetrical (Fig. 9). An asymmetrically functioning spindle which has been observed in pollen grains of various plant species was never found in *R. arnoldi*. However, the two groups of sister chromosomes did not uncoil synchronously during the telophasic reconstruction process. The tube nucleus is restored first while the generative nucleus remains pressed to the cell wall as an amorphous mass of chromatin and retains its stainability. Later, when the telophasic reconstruction of the tube nucleus is completed and has moved to the center of the cell, the generative nucleus loses its stainability and moves away from the cell wall. The generative nucleus has a dented or half-moon shape, whereas the vegetative one is larger and spherical. Some cytologists have suggested that the differential behavior of the daughter nuclei in the pollen grain might be connected with a supposed unequal distribution of DNA-containing substance between the vegetative and the generative nuclei. If

such a difference exists it must be predominantly qualitative. The two separating groups of chromatids never show any detectable difference in their structure or in their nucleic acid charge. Therefore, we have no indication



FIGS. 14–18. FIGS. 14 and 15. Anther, transverse and longitudinal sections. The numerous cylindrical cavities (about 40) are slightly curved. FIG. 16. Processus attached to portion of disc. A processus, B portion of disc with portion of anther groove. FIG. 17. Anther grooves with anthers. A anther, B anther grooves separated by septa bearing tiny stiff hairs. FIG. 18. Diagram of mature male flower.

that there is a quantitatively unequal distribution of DNA between the daughter nuclei.

Structure of the tapetum cells. The cavities of the anthers are lined, usually, by two layers of tapetum cells. These cells are uninucleate and rich in cytoplasm. They absorb much more stain than the surrounding diploid cells when stained by fast green, and stand out from the parenchyma with a sharp border of a brilliant green. The same uninucleate condition of tapetum was found by Ernst and Schmid in *Rafflesia patma*. The nuclei of the tapetum cells of *R. arnoldi* seem to be diploid. However they have a remarkable structure in the resting stage. The chromosomal threads seem to be charged unevenly with an unusually high amount of matrix-like DNA-containing substance. The short, uncharged segments alternate with longer, heavily charged ones and are so arranged that the charged segments seem to be connected end to end by a very short uncharged segment. The number of overcharged segments per nucleus vary between 10 and 15. They look like large heterochromatic blocks, however they are present only in the tapetum, consequently they seem to have a special function connected with the secretory-nutritional function of the tapetal layer.

Fig. 10 shows tapetal cells, and Fig. 11 shows one of the tapetal nuclei, greatly enlarged. This is the usual appearance of the tapetal nuclei before and during the first haploid mitosis. However, in those cavities in which the pollen grains have already completed their development, the tapetal cells are shrunken. Feulgen staining revealed that the chromosomes are not as heavily charged by DNA as before. This supports the supposition that the tapetal nuclei are involved in a secretory-nutritional function connected with the pollen grain development. In other words, DNA seems to be released from the tapetal nuclei and might be taken up by the dividing microspores as supply for the completion of their DNA content. Chromatin extrusion of the tapetal cells, observed by Cooper (1952) in *Lilium*, was not found in *R. arnoldi*.

The development of ovules in the female buds. Ernst and Schmid, (1913) found in *R. patma* all the stages of development of the ovules and of the embryo sac. The process of fertilization was observed also. They agree with the earlier and very incomplete observation made by Solms-Laubach (1891) that in the same bud very differently developed ovules might be found. An attempt was made to follow the development of the ovules in *R. arnoldi*. In the three buds investigated (Figs. 4, 5, and 6) single celled megaspores and embryo sacs with 2 or 4 nuclei were found. However a fully developed embryo sac was not observed even in the largest female bud (Fig. 6). The location and structure of the ovules were essentially the same as those described by Ernst and Schmid for *R. patma*.

Karyotype of the haploid set. The number of the haploid set of chromo-

somes is 12. The length of the chromosomes varies between 3 and 11 microns. The single SAT chromosome possessed a submedian centromere and its satellite is located on the end of the short arm connected by a short nucleolar thread. The 10 micron long chromosome had a submedian contromere. However, the remaining 10 chromosomes did not possess a detectable second arm. Detailed analysis was made of chromosome movements and the exact location of the centromere. Based on this study it was concluded that 10 of the chromosomes are monobrachial. However, the author is fully aware of the unfavorable conditions that exist in pollen grains for such study as the detection of a tiny second arm. Battaglia's standardized method for diagrammatic representation of chromosome morphology was used. The formula of the haploid set, using Battaglia's symbols, is shown in Fig. 19.

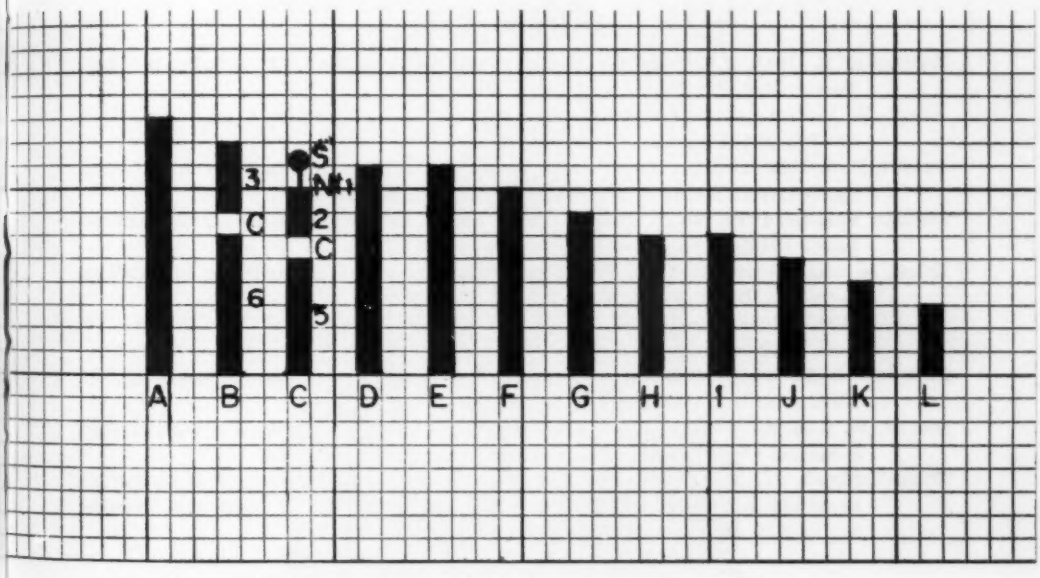


FIG. 19. A symbolic representation of the karyotype of *R. arnoldi*
K = A(11) + B(6C3) + C(5C2,Ntl,S) +
D(9) + E(9) + F(8) + G(7) + H(6) + I(6) +
J(5) + K(4) + L(3); d = 1; mag. 2000 ×
Chromosome (L) may be a sex chromosome?

It was supposed that the smallest choromosome might be involved with the process of sex determination. However, a definite identification of the sex chromosome remained an unsolved problem.

SUMMARY

A field expedition was carried out by the author in Central Sumatra in order to collect *Rafflesia arnoldi* for cytological purposes. The following

habitats were visited: Padangtinggi, Batang-Palupuh and Halaban on the volcano Gunnung Sago. Eleven buds, one flower, and a few wilted flowers and fruits were collected. In one male bud 14.5 cm. in diameter, the first haploid mitosis was found in the pollen grains. The number of the haploid set of chromosomes is 12. The karyotype of the haploid set was established using Battaglia's system for the symbolic representation of the chromosomes. The structure of the nucleus of the tapetum cells was studied, and a nonsynchronized telophasic reconstruction of the daughter nuclei found in pollen grains was described. It was pointed out that the meiotic division may be expected to occur in buds 13–15 cm. in diameter and 11–12 cm. in height. A morphological study was made on the buds and flower. The bud used for cytological study was identified as *Rafflesia arnoldi* R. Br.

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BULLETIN OF THE TORREY BOTANICAL CLUB
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TORREYA

John Wesley Shive.

While preparing to start out with his boat on one of the fishing trips that he enjoyed so much during recent years, Dr. Shive died of a heart attack on June 22, 1960 at Barnegat, New Jersey at the age of 83 years. His was a remarkable life spent in the general field of botany and more particularly in plant physiology. Born in Halifax, Pa. and showing an early interest in biology, Dr. Shive received the Bachelor of Philosophy and Master of Arts degrees from Dickinson, majoring in botany and specializing in biology, chemistry and physics. He taught at the Perkiomen Boys School and at one time also taught Latin.

JOHN WESLEY SHIVE
Feb. 13, 1877–June 22, 1960

In 1915 he received the Ph.D degree from the Johns Hopkins University majoring in plant physiology under Burton E. Livingston with special training in botany, organic chemistry and physiological chemistry. During his graduate residence he assisted in research at the Desert Research Laboratory at the Carnegie Institution of Washington at Tuscon, Arizona and became acquainted with the plant life of the west, an interest he retained during later life when he traveled extensively through the National Parks.

While at Johns Hopkins, he commenced what was to become a life-time of research in plant nutrition in the devising and testing of inorganic nutrient solutions. It was natural for him to continue this work when in 1915 he was appointed Plant Physiologist at the N. J. Agr.Exp. Sta. and Lecturer in Plant Physiology in the Department of Botany under the well known botanist and plant physiologist, Byron D. Halsted.

In 1918 the Department of Plant Physiology was constituted in the College of Agriculture and Dr. Shive was named as its first head. He alone led the research program

and taught a full teaching program of graduate courses and an undergraduate course in plant physiology until 1933 when this author joined the department. His was a truly great effort.

In addition to the devising, formulation and testing of nutrient solutions his research interests included much work on the trace elements of which iron received considerable attention, followed by manganese. Iron and manganese were found to be intimately related in trace element nutrition. Much work was given to the boron requirement and nutrition and to the relation of the trace element to certain of the other essential nutrients principally calcium and potassium. He was also interested in the quality and organic composition of the plant as related to the inorganic nutrient supply. The possibility of growing plants with nutrient solutions without soil intrigued the lay public and became known as "hydroponics." Although usually not practical where fertile soil is available for commercial crop production, valuable uses have been made under certain special conditions of these methods based on the early systematic research with nutrient solutions such as Dr. Shive carried out.

He continued actively in the program of research and graduate teaching until 1946 the year of his official retirement at the mandatory age of 70. To assist with the great post-war influx of students he gladly continued with the graduate teaching several years thereafter.

Dr. Shive was recognized as a top botanist. In 1938 he was starred in the American Men of Science and he was elected to honorary membership in the Royal Agricultural Society of Sweden. He also received the Stephen Hales Award and the Charles Reid Barnes Awards from the American Society of Plant Physiologists for outstanding service in the realm of plant physiology. At the time of his retirement in 1946 Rutgers conferred on him the honorary degree of Doctor of Sciences. He was a long-time member of the Botanical Society of America and a charter member of the American Society of Plant Physiologists, serving as its president in 1939. He served as associate editor of the Bulletin of the Torrey Botanical Club and of the journal Soil Science.

Dr. Shive was a thorough-going scholar scorning shallowness. He was soundly analytical and very skillful in developing a line of productive research. He was a teacher and a leader of graduate students with a great enthusiasm for research. When needed he himself could and did construct wells and he repaired greenhouse walls during his earliest years at Rutgers. The thoroughness of his instruction and the integrity of his research and writings earned for him deep respect.

He was unassuming with a simple dignity and was warm hearted. He listened well, thought much, and talked sparingly. He was generous in sharing authorship credit for research carried out under his supervision.

Dr. Shive was very fond of the outdoor life. He enjoyed excellent health and had a strong constitution. He played a daily strenuous game of tennis for many years. He enjoyed hiking, belonged to the Outing Club, went camping with his sons and visited the western National Parks several times.

One of his hobbies was photography and he prepared lantern slides for class instruction for many years. He took a series of beautiful color slides of plants and animals and scenic views during his trips to the National Parks and was generous in showing them to many audiences and to his friends. He became particularly interested in growing roses and the rose garden at his home was for many years a delight to see.

In 1952 he and Mrs. Shive moved from New Brunswick to Barnegat, New Jersey. Here he was nearer to the fine salt-water fishing grounds of New Jersey where he operated his small out-board driven boat on Barnegat Bay and occasionally went deep-sea fishing. As with everything he did, he was an excellent fisherman and was a welcome passenger aboard a party boat often leaving much of his catch with the captain.

Mrs. Kate Shive who survives him in good health helped to make a good home and also often contributed her services by typing letters and reports for Dr. Shive before he had a secretary in the department. She retains her keen intellect and ready wit. Their two sons graduated from Rutgers. Following in his father's footsteps, John, the older son, obtained a Ph.D. degree in Physics from Johns Hopkins. Scott the younger became

an engineer. It is understandable how genuinely pleased Dr. Shive was when as president of the Rutgers Chapter of Phi Beta Kappa he was privileged to help initiate his son John into Phi Beta Kappa membership at Rutgers.

Dr. Shive was identified with the Plant Sciences at Rutgers through the Botany Department and the College of Agriculture for over a generation during a very important period of development of the College. Many of his former students are still on the campus as members of the faculty and the influence of his teaching and research will be felt for many years to come.—W. Rei Robbins, College of Agriculture, Rutgers—The State University.

The Internal Characteristics of Winter Buds

Joseph Monachino

The identification of our trees and shrubs in winter by means of bud and twig gross morphological features has been accurately developed. The external appearance of the bud is employed exclusively in the standard manuals, and indeed more is not usually necessary for reliable identification. The study of the inner structure of winter buds by use of a dissecting microscope, however, is here recommended as an interesting project.

It is amazing how the expediency of simple dissection is often simply neglected (except, of course, in the established practice of flower dissection, etc.). As though the value of the technique needs illustration, I shall relate from my personal experience how merely opening a bulb, a fruit and a bud solved three identification problems. Then I'll proceed for the remainder of the paper to mention briefly some interesting characteristics of winter buds that I have observed.

The Division of Plant Exploration & Introduction of the U. S. Department of Agriculture sent me a bulb for determination in 1951. I recognized it as an article of food sold in the Italian markets in Manhattan's Hell's Kitchen, where it is called "cipolletta" or "cipollina," meaning little onion in Italian. F. J. Hermann had come across the same thing in a Market in Washington, D. C. The cipollina certainly suggests a small common onion, but it is odorless and costs trice as much. The taste of the identical article may be at the same time very bitter or tasteless, depending on the person tasting! I had already identified the bulb as *Muscari* (grape hyacinth) simply by dissecting it. Its center clearly revealed the inflorescence, a dense spike on a short scape, the minute flowers 6-merous and with superior ovaries. E. J. Alexander subsequently checked the identification by actually growing the plant. Dr. Jones, Division of Vegetable Crops, U.S. Dept. of Agriculture, identified the cipollina as *Muscari comosum*, but it may be that more than one related species are involved.

An old battered maple-samara with damaged wing was submitted for specific identification. Opening the fruit revealed its cell-wall within closely invested with silky indumentum. *Acer pseudo-platanus* (sycamore maple) is the only species of maple I know which has appreciable pubescence within its fruit-chamber. I have examined all the local species native and commonly cultivated.

An autumnal branch of a shrub grown in Denmark was mailed to us for naming. The leaf suggested *Rhamnus* (buckthorn), but no specimen in the New York Botanical Garden Herbarium matched it. Opening a bud revealed flowers, unmistakably of *Rhamnus*. Now certain of the genus, I could place confidence in the description and concluded the species to be *R. imeretina*, native to the Near East. E. J. Alexander (1938) mentions the dissection of flower buds to distinguish the silver and red maples. Flower details can be examined in most of the early blooming shrubs and trees; e.g. *Orixa*, *Euonymous sanguinea*.

Now follow some of my experiences with the inner composition of buds. I do not cite dates for my observations, as, in general, the buds of ligneous plants are fully developed in autumn and remain little changed until the commencement of the growing season.

Within the bud of *Rhododendron viscosum* (clammy azalea) the leaves have strongly

revolute margins. A cross-section of the leaf appears like the scroll in the Ionic capital of the Greek column. In *Populus* (poplar) the margins are involute. Schneider (1903) has a figure showing this for *P. nigra*. Involution appears also in *Viburnum prunifolium* (black-haw) and *V. alnifolium* (hobblebush). The leaves in the bud are conduplicate in *Zelkova, Ulmus* (plaited-nerved), *Corylopsis* (winter hazel), and *Amelanchier* (serviceberry).

The vernation in *Liriodendron* (tulip-tree) is regarded as classic in beauty, and has been described. Concerning the bud-scales, Trelease (1925) said they represent the stipules of the lowermost leaf of the next year. On the contrary, it appears to me that the pair of scales are the stipules of last year's terminal leaf (probably reduced, judging by the reduced leaf-scar). Rather than the leaf being protected by its stipules, it shelters with its stipules the next leaf and is itself covered by the stipules of the previous leaf. Check this!

Aesculus (horse-chestnut) might serve as the classic example for compound leaves. The palmately arranged leaflets are conduplicate in themselves and applanate to each other; the marginal leaflets are folded toward the center for compactness. In *Carya* (hickory), the leaf-rachis is shortened, obscuring the pinnate arrangement of the adult leaf; the leaflets are not in a flat plane but in an arching series, like fingers in a cupped hand. Also see the complex orientation in *Fraxinus* (ash), too difficult to describe easily. In *Staphylea* (bladder-nut) the terminal leaflet is sessile, not stalked as in the adult leaf; the margins of the leaflets are involute. Hardly visible primordial buds are sometimes detected in the axils of the outer scales of full-grown winter buds in *Staphylea*.

Acer saccharum (sugar maple) has the lobes of the bud-leaves conduplicate and applanate; they are folded like wings of a butterfly when first emerging. The lobes are also conduplicate-applanate in *Liquidambar* (sweet gum); the blade is not in a flat plane, but cupped. The bud-leaves of *A. platanoides* (Norway maple) look like talons or the webbed feet of water-fowls. The bud is facially glabrous, but the two innermost scales, preceding the leaves are abruptly dusky-fulvous silky or satiny blackbrown in a truly striking dramatic way. There is no abrupt transition from almost glabrous to hairy in *A. pseudo-platanus* and the pubescence is silvery or faintly browntinted, not dark-fulvous. The compound character of the leaf in species of maples like *A. negundo, A. griseum* and *A. nikoense* (the buds are similar to those of *A. saccharum* in these two) is not too clear; the the bud-leaf may appear deeply lobed only, although careful examination will reveal some differences. There is no web-like tissue between the lobes.

The lobed or unlobed character of the leaves of *Viburnum acerifolium* (dockmackie) and *V. recognitum* (arrow-wood) are clearly exhibited in the bud. The elegant katsura-tree, *Circidophyllum*, has bud-leaves daintily denticulate, their margins minutely dotted with oval or disk-like colorless waxy glands or balsam-like globules. Malpighiaceous hairs are distinct in the bud-leaves of *Cornus alternifolia* (pagoda dogwood), the characteristic excrescens (glands) are along the leaf midrib in *Aronia*. In some specimens of *Viburnum opulus* (European cranberry-bush) I saw knobby glands at the apex of the petiole, but in others the glands were lacking: why?

The relative size of leaves and stipules sometimes changes greatly as one progresses toward the center of the winter bud. In *Ulmus* (elm) and *Rhamnus cathartica* the stipules are larger than the blades immediately beneath the bud-scales; toward the center of the bud the reverse is true. The internal arrangement in the *Rhamnus* suggests that the scales are stipules. The stipules within the bud are obvious in *Cercis* (redbud), *Aronia, Amelanchier, Malus, Liquidambar*, etc., even though sometimes the twigs do not show stipule-scars.

The stipules in *Platanus* (sycamore) are interestingly complicated. They appear as either entire caps (outer members) or open cylinders (inner). The outermost, the budscales, are glabrous; they are gummy internally, as though in the tissue between the outer and inner surfaces. The inner scales are hairy dorsally, but have a narrow glabrous

band at one side. It appears that the stipules of one leaf enclose and protect the succeeding leaf.

The inner bud-scales or leaves of *Nyssa sylvatica* (tupelo) are silky pubescent, smoky-silver, dusty-fulvous or sometimes russet. The bud-scales of *Viburum plicatum* (double-file viburnum), dull and stellate-tomentose outside, are glabrous and often bright russet within. Those of *Orixa* (family Rutaceae, cultivated in the botanic gardens at the Bronx and Brooklyn), particularly the inner, show rutaceous punctations. The inner bud-scales and leaves of *Gaylussacia baccata* (black huckleberry) bear resinous atoms. The buds are glutinous within in *Virburnum opulus;* in *Idesia polycarpa* (family Flacourtiaceae, cultivated in the botanic gardens of Brooklyn and the Bronx) they are so gummed up that the leaf details are difficult to examine. Fernald says the bud of *Betula papyrifera* (paper-birch) is scarcely resinous; yet a specimen I once examined was quite glutinous within. Check other specimens for constancy!

Trelease (1925) wrote that the bud-scales of *Corylopsis* are glabrous—and so they are, smooth, shining and glabrous dorsally. But within they are closely silky, like the inner surface of the chestnut shell. Schneider (1903) had observed this. Also glabrous outside but hairy within are the bud-scales of *Photinia beauverdiana* (not of *P. villosa*), *Koelruteria, Caragana, Ginkgo.* In the last mentioned, the maiden-hair tree, the inner scales of the flower buds become almost glabrous and notched at the apex; they are pellucid punctate.

It is not my intention to suggest that the internal composition of winter buds will reveal anything of vast importance for taxonomy, although it is true that vernation (conduplicate vs. convolute) is regarded as a key character in *Prunus* and *Malus.* James Sinclair (1937) found bud ptyxis (vernation) and the presence of scaly indumentum on leaves interrelated, the two types, convolute and revolute, being directly related to the lepidote and elepidote series. The project is recommended merely as an easy adventure in a little-studied field, for a time when there are here few living flowers or leaves except within the buds.

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Field Trip Reports

June 19. Van Cortlandt Park, Bronx, N. Y. The plan was originally for the study of insects, but Dr. Pallister's illness modified it somewhat. Young Andy Moldenke substituted competently in this department. The undersigned devoted his time to botany, particularly since a member had a hand in Gleason's Plants of the Vicinity of New York (1935). It may be recalled that the Chairman of the Field Committee had repeatedly urged that this handy manual be brought up-to-date. We are now informed that Dr. Gleason himself has happily undertaken the job. The chief improvement in the book should consist in interpolating the many adventive species that are extant, sometimes profusely, in our local area but are not mentioned therein at present; e.g., *Bassia hirsuta, B. hyssopifolia, Cycloloma atriplicifolia, Mirabilis nyctaginea, Geranium sibiricum, Anthriscus sylvestris, Conium maculatum, Helianthus laetiflorus, Lactuca stolonifera, Tragopogon major.* Some of the species observed in the Van Cortlandt Park area but left out in the Vicinity manual are: *Humulus japonicus, Broussonetia papyrifera, Amaranthus lividus, Lynchnis coronaria, Cabomba caroliniana, Clematis dioscoreifolia, Brassica rapa, Bereberis thunbergii, Sedum sarmentosum, Vicia villosa, V. dasycarpa, Callitriche stagnalis, Celastrus orbiculatus, Acer platanoides, A. pseudoplatanus,*

Ampelopsis brevipedunculata, Epilobium hirsutum, Aegopodium podograria, Mazus japonicus, Lonicera morrowi, Hieracium florentinum, Centaurea vochinensis, Eupatorium serotinum, Galinsoga ciliata. The list might be extended greatly; some additional species readily recalled from Torrey trips held within the past year are: *Betula papyrifera* (a large stand near Forest View along Palisades shore walk), *Aristolochia durior, Polygonum sachalinense* (steadily becoming more common), *Rumex pallidus, Myosoton aquaticum, Silene cserei, Ribes sativum, Lespedeza striata, Croton capitatus, C. glandulosus, Euphorbia esula, Viola arvensis* (southern New Jersey), *Myriophyllum heterophyllum, Nymphoides peltata, Verbena bracteata, V. stricta, Chaenorrhinum minus, Plantago indica* (Van Cortlandt Park site apparently destroyed, but species found elsewhere), *Heterotheca subaxillaris* (the New York plant named a variety of *H. latifolia* by Wagenknecht in 1960), *Iva xanthifolia.* Attendance about 25. Reported by Joseph Monachino.

July 10. Esopus Gorge, Ulster County, Kingston, New York. This was a joint meeting of the Torrey Botanical Club and the John Burroughs Natural History Society at the home of Mr. and Mrs. Henry F. Dunbar. The morning was devoted to a tour of the Dunbar wildflower garden which contains about forty species of ferns native to Ulster County. Two other plants of unusual interest in the garden were *Anagallis caerulea* (with blue petals) and *Viola convicta* (*V. fimbriatula* × *V. palmata*). The group lunched in a white pine grove where they were served coffee by the Dunbars with good Jersey cream from the Dunbar cow. After lunch a circuit of points of interest was made, first visiting a large specimen of the hybrid oak, *Quercus Saulii* (*Q. alba* × *Q. prinus*). The remainder of the afternoon was spent examining the banks and gorge of Esopus Creek. Here were growing a number of plants normally found much farther north such as *Achillea borealis, Cryptogramma Stelleri, Sedum rosea* and *Woodsia alpina.* The ecology and botany of this gorge is described in greater detail in Rhodora **61**: 21–24, 1959. Mrs. Dunbar investigated a spot in the creek where she had observed a deer at length, eating something from the creek bed in about of a foot or less of water. The only plant she found there was a dense mat of seaweed-like growth which proved to be *Podostemum ceratophyllum,* a rarity in the Torrey range. Harry Lehr called the attention of the group to the prostrate matted form of *Apocynum sibiricum* growing on the gravel beds of the creek. It is known in the manuals as forma *arenarium* and its ecology here is similar to that which Mr. Lehr has observed in Rockland County, New York. Along the gravelly or sandy beaches of the Hudson River its habit of growth is that of the typical species, i.e., erect or ascending. Attendance: Torrey Botaineal Club 14, John Burroughs Society 18. Leader, Henry F. Dunbar.

August 21. Piermont Marshes, Piermont, Rockland County, New York. High tides prevented an incursion into the marshes proper but many halophytes were observed along its borders including a depauperate specimen of *Samolus parviflorus.* Attendance 14. Leader J. Harry Lehr.

LOCAL FLORA NOTES

The author of these notes has found a second station for *Bunias orientalis* in Rockland County, New York. This new station is about ten miles from the area where the original collection was made in 1954. It has become fully naturalized at its first station, spreading into adjacent fields and roadside. In the area where it was discovered a second time scores of plants were found growing in the immediate vicinity indicating its probable naturalization there also as a weed. Gleason's new Britton and Brown gives its range "as a weed in N. J. and Mich.; adventive at Philadelphia."

* * * * *

The writer and Mr. John Price while botanizing in Stony Point Township, Rockland County, New York on July 4, 1959 found a few plants of *Rudbeckia serotina* forma *viridiflora* (with green ligules). The author collected material for vouchers and

Mr. Price collected a single plant which he transplanted to his garden. This transplant has flowered again this year (June 20, 1960) but the ligules this year are not green but a pale yellow approximating Ridgeway's Lemon Yellow.

* * * * *

While botanizing along the railroad tracks in Orangeburg Township, Rockland County, New York the write was told by the foreman of a section gang that they had found *Saponaria officinalis* (Soapwort) the most efficient agent for removing creosote stains from the worker's hands. On the same day, beside the same tracks, Mr. John Price and the author of these notes found a specimen of *Rhus Vernix* (Poison Sumac) which must approximate record proportions. It was about thirty feet high with branches spreading from the base to a width of about forty feet. The circumference of the branches approximated four to six inches. Exact measurements were not made—even the cause of science has its limitations.

* * * * *

Any inquiry into floras of the local range which have been published since the issuance of Taylor's "Flora of the Vicinity of New York" in 1915, must take cognizance of "Ferns and Flowering Plants of the Audubon Center, Greenwich, Connecticut," printed in 1955. Although slanted for students and visitors at the Center, it is the result of eight years of thorough scientific study. It was written by Leonard J. Bradley, President of the Connecticut Botanical Society and naturalist at the Center but other students of the local flora also contributed to the data. In addition, specialists were consulted in the determination of the more difficult genera and species. The list is available at the Center and its cost is one dollar.

* * * * *

The most recent addition of floras of the Torrey range is Bulletin #91 published by the State Geological and Natural History Survey of Connecticut. It is titled "The Flora of Windham County—a Check List" by Alan W. Upham, available from the State Librarian, State Library, Hartford 15, Connecticut. Its cost is fifty cents. Leonard J. Bradley, President of the Connecticut Botanical Society, in correspondence with the writer made this pithy commendation of the Windham study. "More than thirty years has passed since Connecticut, as a whole, has published a plant list. Now, one of the State's eight counties has been brought up to date by this excellent contribution from the pen of Alan Upham. The author was, for many years, a personal friend of the late Charles A. Weatherby, who worked with him on many of his problems, both in the field and in the herbarium. He also had access to Mr. Weatherby's personal collections. This contact has undoubtedly contributed to the remarkable accuracy of the work, but only years of diligent search in the field and weeks of research in the herbaria of the region, and in the published and unpublished reports of others can account for the completeness of this check list. The author is to be congratulated on this valuable addition to the Connecticut flora."—J. Harry Lehr.

Book Reviews

Plant Pathology, An Advanced Treatise, Vol. II, The Pathogen. Edited by J. G. Horsfall and A. E. Diamond. 715 pages. Academic Press, New York and London. 1960. $22.00.

The Pathogen, the second of a three-volume "integrated synthesis of the parts of plant pathology," covers parasitism and pathogenism. In the introductory chapter the editors state the purpose of this volume, clarify terminology, discuss the problem of naming diseases, and question the use of the word incite. A pathogen is defined as an agent that generates "suffering" in the plant, and is further recognized as being either animate or inanimate. The problem of what to do with a virus is avoided by placing viruses in a class by themselves. Even though the editors place considerable emphasis on the fact that a pathogen can be any disease-causing agent, it is interesting to note

that only animate pathogens and viruses find a place in *The Pathogen*. The frequent implication that certain faults that exist today in the science of plant pathology can be attributed to mycologists is unnecessary and causes one to question the objectivity of the authors.

The concept of parasitism is well presented in the second chapter by George L. McNew. In this major chapter he discusses such topics as the physiology of pathogenicity, natural processes of pathogenesis, evolution of parasitism and pathogenicity, and the law of host-parasite balance in pathogenesis.

The remainder of the volume covers pathogenicity—the ability of a pathogen to generate disease. Three chapters deal with reproduction, six with the nature of pathogenicity, and four with inhibiting the pathogen. The chapters on reproduction include The Multiplication of Viruses by F. C. Bawden; Reproduction of Bacteria, Actinomycetes, and Fungi by Lilian E. Hawker; and Spore Germination by Vincent W. Cochrane. Phases of pathogenicity are presented in The Mechanical Ability to Breach the Host Barriers by Sydney Dickinson; Chemical Ability to Breach the Host Barriers by R. K. S. Wood; Interaction of Pathogen, Soil, Other Microorganisms in the Soil, and Host by T. S. Sadasivan and C. V. Subramanian; Toxins by R. A. Ludwig; Heterokaryosis, Saltation, and Adaptation by E. W. Buxton; and Genetics of Pathogenicity by T. Johnson. The chapters on inhibiting the pathogen include Virus Inactivation *In Vitro* and *In Vivo* by R. E. F. Matthews; Physiology of Fungitoxicity by Hugh D. Sisler and Carroll E. Cox; Fungicidal Chemistry by Saul Rich; and Nematocides by M. W. Allen.

All contributors to *The Pathogen* are closely associated with current research in the areas assigned to them. Therefore, most chapters are not mere reviews, but include criticisms, speculations, and theories which, as F. C. Bawden points out, serve a useful purpose as stimulators of research. Research is moving so rapidly in some of the areas covered that certain chapters could soon be out of date.

All in all, *The Pathogen* is a stimulating presentation of the subject. Bawden's concluding statement in the chapter on virus multiplication could apply to the entire volume: "It will serve its purpose if the obvious gaps in knowledge indicate what significant discoveries there are yet to be made and attract more workers to a subject that promises to yield results that will be important and significant, not only in plant pathology, but in most branches of biology."—EUGENE H. VARNEY, Department of Plant Pathology, Rutgers, the State University, New Brunswick, New Jersey.

Plant Pathology, An Advanced Treatise: Vol. III, The Diseased Population, Epidemics and Control. Edited by J. G. Horsfall and A. E. Dimond. 675 pages. Academic Press, New York and London. 1960. $22.00.

This is the last of a 3-volume treatise on plant pathology edited by Horsfall and Diamond of the Connecticut Agricultural Experiment Station. Sixteen authorities compiled the material in the 14 chapters on various phases of epidemics and control. Horsfall and Diamond introduce the subject of the disease population in Chapter 1. This is followed by a chapter by S. D. Garrett on the inoculum potential. Various phases of dispersal are treated by A. E. Muskett, L. Broadbent, C. T. Ingold and Harald Schrödter in 4 chapters. Three chapters are devoted to epidemics, one on analysis by J. E. Vander Plank, a second on forecasting by Paul E. Waggoner, and the third on biological interference with epidemics by H. Darpoux. Quarantines are treated by Ernst Gram, cultural practices in disease control by Russell B. Stevens, and soil treatment by W. A. Kreutzer. The remaining two chapters deal with the performance of fungicides on plants and in soil—physical, chemical and biological considerations by H. H. Burchfield and the problems of breeding for disease resistance by E. C. Stakman and J. J. Christensen.

This volume as well as the preceding 2 volumes is designed for the advanced student and the professional plant pathologist. It contains a wealth of detailed information as well as well founded generalizations. The important references at the end of each

chapter as well as the author and subject matter indexes are very valuable to the student, teacher and researcher. This and the other two volumes present the basic principles and concepts of our field.—B. H. DAVIS, Department of Plant Pathology, Rutgers, the State University, New Brunswick, New Jersey.

The Garden Flowers of China. By H. L. Li. 240 pp. Ronald Press, New York. 1959. $6.50.

Western horticulturists who have given any thought at all to the geographical origins of the species that have contributed to the garden floras of North America and Europe are well aware of the importance of the Chinese element. One need not accept without reservation the late E. H. Wilson's view that China is the "mother of gardens" to appreciate the great contribution which that country has made in providing us with sources of germ plasm now represented in many of our finest horticultural plants.

An obvious, but often overlooked fact, about Chinese plants in our gardens is that by far the greater number of them are ornamentals. Our vegetable gardens, herb gardens and orchards owe much less to China than they do to Europe and to the Americas. It is important, therefore, to remember that the book we are discussing deals with the garden flowers of China, which term the author uses for flowers grown in western gardens that are based on Chinese species. And what a wealth of such there are! Peonies both herbaceous and tree, Chrysanthemums, Camellias, the Narcissus called Chinese Sacred Lily, certain most important Roses, Day Lilies, many true Lilies, Hollyhocks, Bleeding Heart, many Primroses, Gardenias, the Sacred Lotus, and a host of magnificent trees and shrubs including Magnolias, Crab Apples, Peaches, Apricots, Viburnums, Azaleas, Rhododendrons, Jasmines, Daphnes, Lilacs, Hydrangeas—, and the list can be extended far beyond this.

The author has done a fine job of presenting his material which includes much information gleaned from original Chinese sources. The only complaint I have is that some of his treatments are rather brief. One wishes, for example, in his discussinos of many trees and shrubs for more of the excellent text that he provides. Happily, at the end of each chapter useful bibliographies are given and researchers will find useful the excellent Bibliography which is Appendix II. This includes a long list of "Older Chinese Works." The chapter "A Historical Sketch of Chinese Horticultural Literature" is fascinating. There is, too, an index to Chinese names and a table of Chinese Dynasties.

The Garden Flowers of China is written in an easy, clear style and is well printed and fairly well illustrated. It's author is a native-born Chinese who holds a Ph.D. from Harvard University as well as degrees from the Universities of Soochow and Yenching. Onetime Professor of Botany at Soochow University he is now Taxonomist at the Morris Arboretum and Associate Professor of Botany at the University of Pennsylvania. This book should certainly find a place in all horticultural libraries.—T. H. EVERETT, Assistant Director (Horticulture) and Curator of Education, The New York Botanical Garden.

The Vegetation of Wisconsin, an Ordination of Plant Communities. By John T. Curtis. The University of Wisconsin Press, xi + 657 pp. 53 textfigures, 66 plates, 30 tables. 1959. $7.50.

During the 1930's and early 1940's, John Curtis produced several treatises on reproduction in orchids. These studies emphasized to him "the importance of a knowledge of the ecological life histories of native plants in any explanation of their behavior in the field or of the behavior of their collective community groups" (page 68). He became convinced that the most efficient way to secure the necessary information is to study related groups of species simultaneously. "Such an approach demanded an intimate knowledge of the phytosociological relations of the flora, the species which commonly grow together, the conditions under which each grew at optimum levels, and the geographic locations where each combination could be found" (pages 68–69). Such data, however, were not available.

In 1946, Curtis decided "to concentrate on collecting this information before intensive work on behavior studies was undertaken" (page 69). This book presents a remarkably compact resume of the first decade of synecological field work by the Plant Ecology Laboratory (P.E.L.) of the University of Wisconsin, during which time 1420 separate stands in various portions of the State were investigated (an average of 2.59 stands per 100 square miles). Integrated with this is a review of earlier work on Wisconsin vegetation. The text is well written and contains a number of interesting and provocative personal theories as well as examples of Curtis' subtle sense of humor. Throughout the text, the basic floristic orientation of the studies is obvious and at times considerations of floristic minutae eclipse the treatment of the general aspects of the vegetation.

From the P.E.L. studies, Curtis and his colleagues have formulated the concept of the vegetational continuum. This concept is the framework for the entire book. In certain parts of the text, one receives the impression that perhaps the author has departed somewhat from the main theme of detailing Wisconsin vegetation to convince the reader of the merits of the continuum concept. However, the integrated presentation of the theoretical aspects of the concept and the description of methods by which data are collected and processed will be of value to every plant ecologist. An outline of tests applied in the field before a given forest stand is sampled is presented on pages 70 to 74. Laboratory methods for data analysis are described on pages 74, and 79 to 82. Methods for comparing communities are discussed on pages 82 and 83 and in the chapter on "Interrelations of communities" (pages 476 to 511). The development of "adaptation numbers" is described on page 94 and methods of ordination of stands along a vegetational gradient or cline by importance values derived from frequency, density, and basal area data are outlined on pages 94 to 95.

Because they are actually all parts of vegetational continua, Curtis considers that the plant communities of a large region cannot be pigeonholed into so many discrete types. However, for the sake of discussion and description, he divides the bulk of Wisconsin's native vegetation into 21 major communities. The southern forest, northern forest, and southern grasslands or prairies are each arbitrarily divided into five segments: wet-mesic, mesic, dry-mesic, and dry. The savanna community is recognized to be composed of four types: oak opening, scrub oak barrens, jack pine barrens, and cedar glade. The remaining two native communities are the northern grassland and the boreal forest. In addition, 14 types of lesser native communities are described: open bog, alder thicket, shrub-carr, northern sedge meadow, southern sedge meadow, fen, bracken-grassland, open cliff community, shaded cliff community, sand barrens, beach community, lake dunes, emergent aquatic community, and submerged aquatic community. "Weed communities" which occur on disturbed areas are divided into those of open places, of forested areas, pasture communities (including prairie pastures, pastures on cleared forest land, and pastures in closed forests), and mowing meadows. A key to the native plant communities, utilizing structure, floristics, site characteristics, and geographical location, is given on pages 56–59.

An excellent pattern of treatment is followed throughout the book for the discussion of the various communities. For the forest communities, each treatment consists of sections on the pre-settlement distribution and area of the community, its composition and structure, life histories of the outstanding tree and undergrowth species, successional trends, regional variation of the community in Wisconsin, the environment (including microclimate and soils), geographic relations with similar communities in other areas, and the utilization and current management of the community. In the discussions of non-forest communities, the only quantitative data given are presence figures. No doubt, future revisions of this book will incorporate more detailed analyses of these communities.

A number of quotations are given from the works of other authors who have made vivid descriptions of various vegetation types, particularly in presettlement times, but Curtis has not attempted to write descriptions from his own experience with the vegetation of Wisconsin. This, of course, is a reflection of the current trend toward complex statistical analyses of data which, unfortunately, has supplanted rather than supplemented the observational-descriptive techniques so desirable in the conveyance of infor-

mation about vegetation. However, this lack of descriptions is partially compensated by the presentation of a number of excellent original photographs of different communities.

Community comparisons are made on the basis of floristic similarity rather than on physical bases, and considerable importance is implied in the comparison of genera in common between communities in Wisconsin and such distant areas as Germany and Russia. To illustrate the shortcomings of such comparisons, one can cite the claim that the jack-pine barrens of Wisconsin and the pitch-pine barrens of New Jersey greatly resemble one another in appearance and behavior (pages 349–350). The physiognomic resemblance between the two areas is slight, except that they both have scrubby pines as aspect dominants. The Wisconsin barrens are classed as savanna communities in which the dominant plants are grasses, forbs, and shrubs, with a scattered stand of trees (page 340, plate 45). The complex upland vegetation of the New Jersey Pine Barrens is composed of a series of forest communities in which trees and shrubs are predominant and grasses and forbs are of relatively little importance. If the similarity of behavior implied between the vegetations of the two areas is their maintenance by fire, it should be recognized that the jack pine bears serotinous cones while the pitch and shortleaf pines revegetate a burned area primarily by sprout growth.

Vegetation maps are considered by Curtis to be very unreliable because of the continuum nature of the vegetation—it gradually blends from one type to another. Thus sharp boundaries between types may not exist and stands which are grouped together are never identical. Further difficulty arises as the scale of the map is reduced because the detail shown on the map is reduced by subjective determinations. In spite of these factors which result in a low degree of precision, Curtis has provided us with vegetation maps of Wisconsin which add immensely to the value of the text. A number of other maps indicate locations of sampled areas in each community type, areas from which fossil pollen samples have been obtained, and various other floristic, geological, and geographic data. It is unfortunate that the maps which appear at chapter heads are not accompanied by legends. The reader must determine their content from the text. In some cases the reader may be unable to make this determination.

In several places, the fundamentally objective pattern of the text is marred by unqualified subjective statements. For example, on page 191 we learn that recent work "on the toxic effects of water extracts of European beech leaves may indicate that an antibiotic reaction is in part responsible for the absence of many herbaceous species." But on page 194, we are told that, in the northern mesic forests of Wisconsin, the degree of aggregation of the herbs "is greatly intensified by the antibiotic effects of the hemlocks and beeches. . . ." A similar confusion of fact and theory occurs on pages 382–383. First, we are informed that, "Some investigators believe that toxic organic compounds are produced by the sphagnum and by the other members of the [bog] community. . . ." Then we are told that the members of the bog community actually "work together to maintain the conditions and prevent encroachment of other plants through antibiotic activity."

There are a number of comments on various parts of the text which are difficult to relate to one another or to any other section of this review. Therefore, they are arranged below in potpourri fashion:

pp. 37–40—An interesting discussion of the reliability of Hopkins bioclimatic laws in Wisconsin is presented.

pp. 74, 134—The use of the term "dominance" for the basal area of a species in terms of square feet per acre and "relative dominance" for the percentage of community basal area contributed by a given species is an unfortunate usage which implies that basal area is *the* true measure of ecological importance. Cover, an exceedingly important attribute of vegetation, may not be correlated directly with basal area and neither cover nor basal area necessarily are correlated with the extent of the root system. On page 316, Curtis associates the largest number of species with dominance, and on page 369, "dominance" is equated to a species' contribution to the total weight of the standing crop in a sedge meadow.

p. 148—The statement that there is a "normal transition [in time] from xeric forest

to mesic forest" confuses an ecological classification of species with a classification of sites used throughout the book. Although floristic succession is meant, physiographic succession is implied.

p. 395—The calculation that *Chara* in Green Lake may contribute as much as 10,000 metric tons of calcium carbonate per year to the marl deposits is based on a report by Schuette and Alder which was in error. On an annual basis, if Curtis' estimate is correct that seasonal production is ten times greater than the amount in the standing crop, the *Chara* in Green Lake contributes 4,900 M.T. to the marl deposits. The further statement that 10,000 M.T. (22,046,000 pounds) per year represents a production of 1000 pounds per acre would require Green Lake to be three times its actual size. With the revised figures presented above, there are approximately 1474 pounds of calcium carbonate produced per acre per year in the entire lake. If one calculates production only for the vegetated area of the lake (8.573 sq. km. according to Rickett, 1924), the resulting figure is a rather unbelievable 5,100 pounds per acre per year.

In the final pages of the book, Curtis presents his "Conclusions concerning the nature of plant communities" (pages 509–511). In this section, the author admits that sharp boundaries between dissimilar vegetation types do occur. However, the concept of continuous change "does deny that each of these sharply defined local groups is a representative subunit of a wide-ranging community which is meaningfully different from other wide-ranging communities. Rather, it says that there is a continuous variation from stand to stand of any particular community, such that those stands which are more remote are more different than those which are nearby, and that the are no inherent limits to the community *in toto*." These continuous interrelationships are considered to invalidate the recognition of separate communities except for the sake of convenience. In summary, Curtis pays tribute to Dr. H. A. Gleason by stating (page 510) that, "The entire evidence of the P.E.L. study in Wisconsin can be taken as conclusive proof of Gleason's individualistic hypothesis of the community organization . . ."

Dr. Curtis and his associates are to be congratulated and thanked for their extensive studies of the vegetation of Wisconsin which are so clearly summarized in this treatise. The book itself is a masterful work which is certain to be recognized as a standard to which future studies of the vegetation of other regions will be compared.

A special note of recognition is due the University of Wisconsin Press for the quality and accuracy of the printing, clear plates, strong binding, and surprisingly reasonable price of the "Vegetation of Wisconsin."—JACK MCCORMICK, The American Museum of Natural History, New York 24, New York.

DECEMBER MEETINGS OF THE A.A.A.S.

TORREY BOTANICAL CLUB PROGRAM

Tuesday, December 27, 1960 — Hotel Biltmore
New York City — (Long Room—18th Floor)

Special Symposium

FUNDAMENTAL DEVELOPMENTS IN PLANT GROWTH

9:00 a.m. Paul Burkholder, Director of Research, Kitchawan Laboratories: Chairman

1. Changing concepts of photosynthesis. Daniel Arnon, University of California (Lantern, 45 min.)
2. Fundamental Developments in the Field of Plant Growth Regulators. John Mitchell, Crops Research Division, U.S.D.A. (Lantern, 25 min.)
3. Alteration of Plant Growth by Chemicals. N. E. Tolbert, Michigan State University. (Lantern, 30 min.)
4. "Plant-animals" as experimental tools for growth studies. Seymour H. Hutner, Haskins Laboratories. (Lantern, 15 min.)

12:00 noon Luncheon

Greetings, Announcements, Informal Remarks
Charles Berger, Fordham University, President
William C. Steere, N. Y. Botanical Garden, Vice-President

2:30 p.m. George McNew, Director, Boyce Thompson Institute: Chairman

5. The photoperiodic control of flowering. Harry A. Borthwick, Crops Research Division, U.S.D.A. (Lantern, 45 min.)
6. Test-tube studies on flowering. William S. Hillman, Yale University, (Lantern, 30 min.)
7. Relation of antimetabolites to plant growth. Thomas H. Jukes, American Cyanamid. (Lantern, 15 min.)
8. Recent progress and the goals of plant tissue culture. Walter Tulecke, Boyce Thompson Institute. (Lantern, 30 min.)

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COMPILED BY

LAZELLA SCHWARTEN

WITH THE COLLABORATION OF THE EDITOR OF BRITTONIA

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